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AND THE RECORDING OF

AMERICAN AND OTHER PATENTED INVENTIONS.

SEPTEMBER, 1832.

## *On the invention and progress of Medal ruling in the United States.*

*By the* COMMITTEE ON PUBLICATIONS.

(WITH A COPPERPLATE.)

During the time when communication, even between neighbouring nations, was not common, similar inventions were frequently made independently in several different countries and at different times: hence, in the progress of information, perpetual disputes arose as to originality, or priority, and much crimination and bitter feeling were produced.

America *has been* without her journals to put forth the claims of her ingenious men, and the credit of more than one invention has passed from her to those who have been able to give greater publicity to their designs; but this day has passed away, and we find notices of the ingenious works of our countrymen transferred to the pages of foreign journals to be appreciated and acknowledged abroad as well as at home.

We propose briefly to set before our readers a correct history of the invention of a *machine for straight and waved line ruling, and for medal ruling*, which the impressions conveyed by the following paragraphs appear to render necessary.

Extract from the proceedings of the Friday evening meetings of the Royal Institution of Great Britain, as given in the Philosophical Magazine and Annals of Philosophy, for April, 1832.

"*February* 3*d.*

"Afterwards the beautiful machine constructed by Mr. Bate, of the Poultry, for producing engravings of medals by machinery applied to the surface of the medal itself, or to that of the cast from it, was shown and explained by Mr. Faraday. Drawings would be required to make the description intelligible here. A plate was partly engraved, and many impressions from other plates were shown. Mr. Bate is still engaged in perfecting this instrument."

We are not told who *invented* this machine, but Mr. Bate's claims appear more distinctly in the terms of a patent which he has taken out.

"John Bate, of the Poultry, optician, for an improvement or improvements on machinery applicable to the imitation of medals, sculpture, and other works of art, executed in relief; six months: April 9."—(*Mechanics' Mag.*)

Believing that the credit of the invention of a machine for medal ruling is due to America, we will briefly set forth our proofs, and then speak of the improvements which of late years the method has undergone.

The proofs to be given of the existence and state of a machine are to be derived from the results produced by it.

In 1817, by the use of a machine which had been invented in Philadelphia, Christian Gobrecht, die sinker, produced upon copper an engraving from a medal, having upon it the head of Alexander of Russia: from this engraving impressions were taken and distributed. One of these impressions we have seen.

In 1819 Asa Spencer, (now of the firm of Draper, Underwood & Co., bank note engravers,) took with him to London a machine of the kind above alluded to, which was designed principally for straight and waved line ruling. This machine was used in London during the year just mentioned, and the mode of ruling waved lines, and of *copying medals*, was then exhibited and explained by Mr. Spencer to several artists; particularly to Mr. Turrell, who took, by permission, a drawing of the machine, for the purpose of having one made for his own use.

Little, however, was done in the way of medal ruling until about three years since, when a desire to apply the method to the engraving of designs for bank notes caused it to be revived by Mr. Spencer, who bestowed great attention upon it, and overcame the difficulties met with in the outset.

The peculiar construction of this machine has never been made a secret, nor has it ever been patented, although prudential motives have required that it should not be minutely described, and thus be placed in the hands of those by whom its use might be perverted. In consequence of this free communication in relation to this machine, it is now made, with modifications in the details, for engravers, by some of our machinists. We have lately had the pleasure of inspecting one of beautiful workmanship, made by Messrs. Tyler, Fletcher & Co.

The operations performed by this machine are the ruling of parallel straight lines at any required distances apart, and either continuous

or broken; ruling converging straight lines; ruling waved lines, the waves being either similar or varying by more or less imperceptible gradations; and medal ruling, or transferring to copper the fac-simile of a medal without injuring its surface, the waved lines presenting a copy of the minutest parts of the medal.

Mr. Bate is said, in the extract which we have given, to be engaged in *perfecting* a machine for medal ruling: in his patent he claims the improvements on a machine for that purpose. It is impossible to say how far this latter claim may be borne out, since a description of the patented improvements has not yet reached us.

That Mr. Spencer has essentially *perfected* this machine as far as beauty of execution, and fidelity of representation in the work to be done by it are concerned, we do not hesitate to say, and that the public here, and our brethren of England, may be enabled to judge for themselves, we have obtained from Mr. Spencer a specimen* of medal ruling executed with his machine, an impression from which we give.

The engraving is made from a copper medal placed in an embossed card of the ordinary kind. The surface of the medal bears not the slightest trace of injury from the machine, and even the yielding surface of the card is not roughened by it.

An impression taken thus from a plate gives but a faint idea of the exquisite effect produced by engravings themselves made by this machine upon a polished surface of gold or silver.

A series of the Napoleon medals, together with a portion of the series of medals struck in commemoration of the events of the first French revolution attest the skill of Mr. Spencer.

If even claims to improvement upon this machine should be established, we trust that what has been here advanced in relation to the invention and progress of medal ruling in this country, will neither be overlooked nor forgotten.

A. D. B.

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*Description of an apparatus used as a substitute for the Lewis in raising heavy stones. By* Wm. Howard, *Civil Engineer.*

TO THE EDITOR OF THE JOURNAL OF THE FRANKLIN INSTITUTE.

Dear Sir,—I send you the description of a hook or lever for raising stone, which I have found very useful for the particular purpose for which it was intended. It is, I believe, new; but it is very possible that your intimate knowledge of whatever has been done in the way of mechanical contrivances, may convict it of being a "modern antique." If *you* cannot find its prototype, I think I may safely lay claim to it as an original invention: and in that case I would thank you to insert this description in your valuable journal, with a hope that it may be found to be of use in other cases similar to that in which I have employed it.

Yours, respectfully,

*Baltimore, July* 31*st*, 1832. Wm. Howard.

* Various specimens of this work have been long since sent to London, and may be found in the possession of Messrs. Perkins and Heath, and of other artists.

DESCRIPTION.

The M'Kim school, now erecting in Baltimore by the liberality and taste of a public spirited individual, is to be an exact copy, as to the portico, of the celebrated temple of Theseus at Athens, and of the precise size of the original. The body of the building is composed of blocks of granite ashler, from Ellicott's mills, each course being of the same height. To permit these blocks to be placed with accuracy and convenience, it was necessary to suspend each one in such manner as to leave its bed and sides entirely free. The Lewis with two pins, represented in fig. 1, and similar to one described in Rondelet, *Art de Batir* was tried, and found to succeed very well, requiring only two holes to be bored about three inches deep, which can be done in the granite with great facility. Still it was desirable to avoid the labour of fitting this Lewis to more than 400 blocks, and the contrivance represented by fig. 2, was invented for the purpose, and has been found to answer perfectly.

It consists of an iron bar, bent in the form A B C D, and of a size proportionate to the blocks of ashler intended to be raised. At C a mortise is made through it, admitting freely the bar H E. This bar is pierced with holes, as shown in the figure, through one of which an iron pin is put, to prevent it from slipping towards H. At F is a plate attached to this bar, between which and the ashler block G, a piece of wood is placed to keep the iron from injuring the worked face of the block. The end D forms a steel pin, which may be inserted about an inch into a hole bored in the block; but in cases where the least projection or shoulder can be found for this point to catch hold of, this labour of boring is not necessary; the smallest prominence being sufficient to give the instrument a perfectly firm hold, or gripe, of the stone, which becomes still firmer as the weight comes to bear on it.

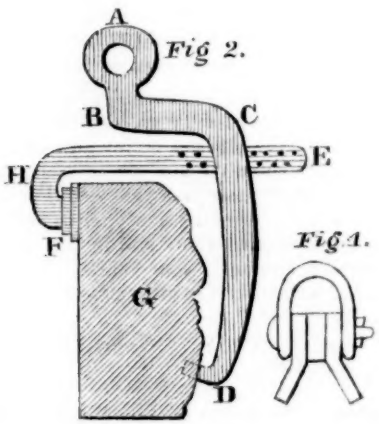


*Fig 2.*

*Fig 1.*

## *Remarks on the Strength of Cylindrical Steam Boilers.* *By* Prof. Walter R. Johnson, *of the Franklin Institute.*

[Read before the Institute at the stated Monthly Meeting, July 26, 1832.]

It has been generally supposed that the rolling of *boiler-plate* iron, gives to the sheets a greater tenacity in the direction of the length, than in that of the breadth. Supposing this to be correct, it has frequently been asked how the sheets ought to be disposed in a cylindrical boiler of the common form, in order to oppose the greatest strength to the greatest strain. It has also been asked whether the same arrangement will be required for all diameters, or whether a magnitude will not be eventually attained, which may require the direction of the sheets to be reversed?

To determine these questions in a general manner recourse must be had to mathematical formulas, assuming such symbols for each of the elements as may apply to any given case of which the separate data are determined either by experiment or by the conditions of the case. The *principles* of the calculation require our first notice.

1. To know the force which tends to burst a cylindrical vessel in the longitudinal direction, or, in other words, to separate the *head* from the curved *sides*, we have only to consider the actual area of the head, and to multiply the number of units of *surface* by the number of units of *force* applied to each superficial unit. This will give the total *divellent* force in that direction.

To counteract this, we have, or may be conceived to have, the tenacity of as many longitudinal bars as there are lineal units in the circumference of the cylinder. The united strength of these bars constitutes the total retaining or *quiescent* force, and at the moment when rupture is about to take place, the *divellent* and the *quiescent* forces must obviously be equal.

2. To ascertain the amount of force which tends to rupture the cylinder along the curved side, or rather along two opposite sides, we may regard the pressure as applied through the whole breadth of the cylinder upon each lineal unit of the diameter. Hence the total amount of force which would tend to divide the cylinder in halves by separating it along two lines, on opposite sides, would be represented by multiplying the diameter by the force exerted on each unit of surface, and this product by the length of the cylinder. But even without regarding the length, we may consider the force requisite to rupture a *single band* in the direction now supposed, and of one lineal unit in breadth; since it obviously makes no difference whether the cylinder be long or short in respect to the ease or difficulty of separating the sides. The *divellent* force in this direction is, therefore, truly represented by the diameter multiplied by the pressure per *unit of surface*. The retaining, or *quiescent* force, in the same direction, is only the strength or tenacity of the two opposite sides of the supposed band. Here also at the moment when a rupture is about to occur, the *divellent* must exactly equal the *quiescent* force.

3. In order to estimate the augmentation of *divellent* force conse-

quent upon an increase of diameter, we have only to consider that as the diameter is increased the product *of the diameter, and the force per unit of surface,* is increased in the same ratio. But unless the thickness of the metal be increased, the *quiescent* force must remain unaltered. The *quiescent* forces, therefore, continue the same—the *divellent* increase with the diameter.

4. Again, as the diameter of the cylinder is increased, the area of its end is increased in the ratio of the *square* of the diameter. The *divellent* force is therefore augmented in this ratio. But the retaining force does not, as in the other direction, remain the same, since the *circumference* of a circle increases in the same ratio as the diameter. The *quiescent* force will consequently be augmented in the simple ratio of the diameter, without any additional thickness of metal. So that on the whole, the total tendency to rupture in this direction will increase only in the *simple* ratio of the diameter.

5. Since we have seen that the tendency to rupture, in both directions, increases in the simple direct ratio of the increase of diameter, it is obvious that any position of the sheets which is right for one diameter, must be right for all. Hence there can never be a condition, in regard to mere magnitude, which will require the sheets to be reversed.

6. The foregoing considerations being once admitted, we may proceed to ascertain what is the true direction of the greatest tenacity in the sheet, if any difference exist, and what that difference might amount to, consistently with equal safety of the boiler in both directions.

7. Let $x =$ the diameter of the cylinder.

$f =$ the force or pressure per unit of surface, (pounds per square inch, for example.)

$\mathrm{T} =$ the tenacity of metal which, with the diameter $x$ and the force $f$, will be required in the lineal unit of the circumference in order to hold on the head.

Then will the whole *quiescent* force be $3.1416\,x\,\mathrm{T}$, while the *divellent* will be $.7854\,x^2 f$; consequently $.7854\,x^2 f = 3.1416x$ as above stated.

Dividing by $.7854\,x$ we have $xf = 4\mathrm{T}$; and we derive immediately—

$$x = \frac{4\mathrm{T}}{f}$$

$$f = \frac{4\mathrm{T}}{x}$$

$$\text{and} \quad \mathrm{T} = \frac{xf}{4}$$

That is, the tenacity of the *longitudinal bar of the assumed unit in width, will be one-fourth of the product of the diameter into the pressure,* measuring the tenacity by the same standard as the pressure, whether in pounds or kilograms.

8. Now assuming the tenacity required in the *circular band* of the same width to be $t$, we shall, agreeably to what has already been said,

have the *divellent* force expressed by $xf$, and the *quiescent* by $2t$, so that $xf = 2t$ and $t = \frac{xf}{2}$. Also $f = \frac{2t}{x}$; and $x = \frac{2t}{f}$.

Having thus obtained two expressions for each of the quantities $x$ and $f$, we may, by comparing them, readily discover the relative values of T and $t$,—thus,

$$\left.\begin{aligned} x &= \frac{4T}{f} \\ x &= \frac{2t}{f} \end{aligned}\right\} \text{ hence } \frac{4T}{f} = \frac{2t}{f} \text{ whence } 4T = 2t, \text{ or } t = 2T.$$

From which it follows, that *under a known diameter, and with a given force or pressure, the tenacity of metal in a cylindrical boiler of uniform thickness, ought to be twice as great in the direction of the curve as in that of the length of the cylinder, and that if this could be the case the boiler would still have equal safety in both directions.*

In whatever direction, therefore, the rolling of metal gives the greatest tenacity, in the same direction must the sheet always be bent in forming the convexity of the cylinder. It follows that if we suppose the tenacity precisely equal in both directions, the liability to rupture by a mere internal pressure, *ought to be twice as great along the longitudinal direction as at the juncture of the head.* This supposes the strain regular, and the rivetting not to weaken the sheet.

9. To know how large we may safely make a cylindrical boiler, having the absolute tenacity of the metal, in the *strongest direction*, and with a known thickness, we have only to revert to the formula $x = \frac{2t}{f}$. That is, *the diameter will be found by dividing twice the tenacity by the greatest force per unit of surface, which the boiler is ever to sustain.*

10. When knowing the absolute tenacity of a metal, or other material reckoned in weight, to the bar of a given area in its cross section, we would determine the *thickness* of that metal which ought to be employed in a boiler of given diameter, and to sustain a certain force, we may use the formula $t = \frac{xf}{2}$, and dividing the latter number of this equation by the *strength* of the square bar, which we may call $s$, we obtain the thickness demanded in the direction of the curve, which we may denominate $p$; so that $p = \frac{xf}{2s}$; this will give the thickness of the boiler plate either in whole numbers or decimals. Thus, suppose the diameter of a cylindrical boiler is to be thirty-six inches—that it is to be formed of iron which will bear 55000 lbs. to the square inch, and is to sustain 750 lbs. to the square inch,—what ought to be the thickness of the metal?

Here $x = 36$
$f = 750$
$2s = 110000$, consequently,

$p = \frac{36 \times 750}{110000} = .2454$, or a little less than one-quarter of an inch.

It must, however, be evident that the *minimum* tenacity of any particular description of metal, is that on which all the calculations ought to be made when there is any probability that the actual pressure will, in practice, ever reach the limit assigned as the value of $f$ in the calculation.

If we had plates of different metals, or of different known degrees of tenacity in the same kind of metal, and were desirous of ascertaining how strong a kind we must employ under a limited *thickness*, *diameter* and *pressure*, we should decide the point by transforming the formula $p = \frac{xf}{2s}$, into $ps = \frac{xf}{2}$, and then into $s = \frac{xf}{2p}$. In other terms, in order to know the strength of the metal required, or the direct strain which an inch square bar of the same ought to be capable of sustaining, we must *multiply the diameter of the boiler in inches by the pressure per square inch in pounds, and divide the product by twice the intended thickness in parts of an inch.*

Thus, how strong a metal ought to be employed to sustain a pressure of 1000 lbs. to the square inch, in a boiler thirty inches in diameter, and one-fourth of an inch thick?

Here $s = \frac{30 \times 1000}{2 \times .25} = 60.000$. Hence we see that the metal must be capable of sustaining *sixty thousand pounds* to the inch bar, or in that proportion for any other size. This formula enables us to determine whether among the metals of known tenacity, *any* one can be found to fulfil the conditions under the thickness assigned.

On the basis of the foregoing formulas the following table of diameters, thicknesses of iron, and strains to the inch of metal, in both directions, has been formed.

It is obvious that the *actual* tenacity of the metal employed in a given case must be of the greatest importance to the result. The extensive series of experiments recently undertaken by the Institute to determine this question in reference to different kinds and varieties of boiler plate, and with regard to the various circumstances of its manufacture and application, will hereafter furnish us with important data to aid in applying the formulas to each separate case. I shall for the present assume the tenacity of an inch square bar of rolled iron at 55,000 pounds, in the direction of the length of the sheet. Supposing the pressure generally employed in cylindrical high pressure boilers to be 150 lbs. to the square inch, agreeably to the practice in this city, the table is calculated upon the principle that the boiler ought to have five times as great a strength as it is ordinarily required to exert. The calculation is upon a continuous sheet of metal without seams in any direction. The thicknesses are given in ten-thousandths of an inch; but in practice the last figure may be omitted without material error.

| Diameter of the boiler in inches. | Thickness of plate iron which will bear 55,000 lbs. to the square inch required to resist the strain in the direction of the curve under a pressure of 750 lbs. to the square inch—calculated by the formula $p = \frac{xf}{2s}$. | Corresponding tenacity of each inch wide ring or band, required to support a pressure of 750 lbs. to the square inch, calculated on the formula $t = \frac{xf}{2}$. | Tenacity required in each longitudinal bar of one inch wide to sustain the pressure tending to burst out the head; calculated on the formula $T = \frac{xf}{4}$. |
|---|---|---|---|
| Inches. | Inches. | Pounds. | Pounds. |
| 1 | .0068 | 375 | 187.5 |
| 2 | .0136 | 750 | 375 |
| 3 | .0204 | 1125 | 562.5 |
| 4 | .0272 | 1500 | 750 |
| 5 | .0341 | 1875 | 937.5 |
| 6 | .0409 | 2250 | 1125 |
| 7 | .0476 | 2625 | 1312.5 |
| 8 | .0545 | 3000 | 1500 |
| 9 | .0613 | 3375 | 1687.5 |
| 10 | .0681 | 3750 | 1875 |
| 11 | .0745 | 4125 | 2062.5 |
| 12 | .0818 | 4500 | 2250 |
| 14 | .0954 | 5250 | 2625 |
| 16 | .1090 | 6000 | 3000 |
| 18 | .1227 | 6750 | 3375 |
| 20 | .1363 | 7500 | 3750 |
| 22 | .1490 | 8250 | 4125 |
| 24 | .1636 | 9000 | 4500 |
| 26 | .1773 | 9750 | 4875 |
| 28 | .1909 | 10500 | 5250 |
| 30 | .2045 | 11250 | 5625 |
| 32 | .2182 | 12000 | 6000 |
| 34 | .2318 | 12750 | 6375 |
| 36 | .2455 | 13500 | 6750 |
| 38 | .2591 | 14250 | 7125 |
| 40 | .2727 | 15000 | 7500 |
| 42 | .2860 | 15750 | 7875 |
| 44 | .2980 | 16500 | 8250 |
| 46 | .3116 | 17250 | 8625 |
| 48 | .3252 | 18000 | 9000 |
| 50 | .3388 | 18750 | 9375 |

13. I am not aware that this subject has been previously treated in a general manner, at least as it regards several of the points above presented. Mr. Oliver Evans made some particular calculations of the strength requisite to sustain the pressure in a boiler of known dimensions, under a tension of 1500 lbs. to the square inch. In the table at page 27th of his "Young Steam Engineer's Guide," he has given calculations for seventeen different diameters of boilers, with the

power which, at each diameter, the steam would exert "to break every ring of one inch wide in any place," and "the thickness of the sheets of good iron necessary to hold the power." His table is formed on the supposition that sheet iron will bear 64,000 lbs. to the square inch, and would consequently lead to considerable *excesses* if strictly applied in practice. To six of the diameters he has annexed the "power exerted on the heads to burst them out in pounds weight." These he has calculated in the usual manner, by multiplying the area by the pressure per inch. Opposite to three of the numbers just mentioned, he has added "the strength of the boiler to hold the head on in pounds weight."

These he has calculated on the supposition that the metal had equal tenacity in all directions. On this supposition, and on the principles above developed, each of these three numbers should have been exactly double of that against which it stands in the preceding column. Neither of the three is so, precisely; but the first and third come as near it as could be expected, considering that the thickness is expressed only in 100ths of an inch; while the second is too small by more than a million of pounds.

These errors would not, I apprehend, have occurred, had the author adverted to the general principle above developed in regard to strength required of the metal in the two directions.

The following extract from the table just alluded to, will illustrate the preceding remarks. A column of corrected results has been added.

(See "Young Steam Engineer's Guide," p. 27.)

| Diameter of the boiler in inches. | Power to break each ring of one inch; pressure being 1,500 lbs. | Thickness of the plate of iron of 64,000 lbs. to the sq. in. | Power exerted on the heads. | Strength to hold on the heads. | Corrected numbers to be substituted for those of column 5, agreeably to the foregoing remarks. |
|---|---|---|---|---|---|
| 42 | 31.000 | .48 | 2.077.500 | 4.052.400 | 4.155.000 |
| 36 | 27.000 | .42 | 1.525.500 | 2.037.440 | 3.051.000 |
| 20 | 15.000 | .23 | 471.000 | 918.777 | 942.000 |

## AMERICAN PATENTS.

LIST OF AMERICAN PATENTS WHICH ISSUED IN MARCH, 1832.

*With Remarks and Exemplifications, by the Editor.*

1. For an *Apparatus for ventilating Vessels, and purifying and cooling the air of Steam-boats;* Jesse Remington, city of Baltimore, March 1.

To be ignorant of the nature and preparation of such an agent as chlorine, is no disgrace to a person whose pursuits have not been scientific; but for one so situated to pretend to have discovered new modes of applying it, manifests a degree of temerity which might well excite surprise were not events of a similar character so common; and that they are common is strikingly exemplified by our monthly analysis of the transactions of the patent office. The instance before us is an example of that utter failure which may well be anticipated when ignorance and temerity, such as we have spoken of, unite in an attempt at scientific investigations, and in a claim to scientific discovery.

It is proposed to make a metallic reservoir of one foot in diameter, and eighteen inches in height, with a screw cap to close it up; and this reservoir is to contain a solution of chloride of lime, or of chloride of soda. A force pump, the cylinder of which is to be a foot in length, and its diameter five inches, surmounts the reservoir, and by it atmospheric air is to be forced through a tube which dips into the solution: from the upper part of the reservoir, above the solution, copper tubes are to lead into the hold of the vessel. This constitutes the whole apparatus, and exhibits all the agents to be employed, unless we count the man who is to work the pump handle. But in what way are these to operate? The patentee says that the atmospheric air being forced by the pump through the chloride, is impregnated with it, and consequently he claims as his invention "impregnating air with chloride in the reservoir as before described; also in giving an agreeable odour to the air when purified by the same apparatus; or conveying pure atmospheric air by the same apparatus."

When air is thus forced into the hold of a ship, or other vessel, it is manifest that were the vessel perfectly air tight, and the operation persevered in *long enough*, she must explode; to avoid such a catastrophe, and to allow of the exit of the foul air, "openings are left in the deck around the mast, or in any convenient situation, for its escape."

When the patentee has informed us in what way the air becomes impregnated with *chloride*, he may next undertake to instruct us in the method of surmounting insurmountable difficulties, or of arriving at the bottom of the bottomless pit. The fact is that by the proposed process, the air of the atmosphere would acquire a slight odour of *chlorine;* and that, principally, in consequence of the action of the minute portion of carbonic acid contained in it, but its influence would be as that of a drop in the ocean. If the patentee had directed the

throwing of the dry chloride, or the pouring of its solution into the hold of the vessel, such direction would have been good, but then his patented apparatus would not have come into play.

The idea of purifying a ship's hold by forcing into it a gallon of atmospheric air at every stroke of a piston is too absurd to be entertained for a moment, yet even this is more rational than the proposed impregnation with *chloride.*

We have been induced to extend our notice of this *invention* to an unmerited length, and our reason for doing this is a knowledge of the fact that application has been made to the Navy Board to adopt this apparatus in the national marine. All we can say in its favour is that it is as harmless as it is useless.

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2. For a *Thrashing Machine;* Nathaniel Adams, Westmoreland, Oneida county, New York, March 2.

The beaters on the cylinder are to be of cast iron, and we are told what is about the proper length for the teeth, and the distance between them, and how they are to be fastened on to the cylinder. The concave is likewise to be cast, and with teeth on it formed by grooves, it is to be suspended on springs regulated by screws, &c. The claim is to these *peculiarities,* if such they are; but the host of thrashing machines is too great to admit of their being mustered and inspected to see whether their accoutrements may not differ in some minute point from that before us. Besides this, after we had taken all the trouble we could, we might fail to accord in opinion with the patentee, a sin we have committed in our last lucubration, and one which we will not repeat until we are compelled to do so.

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3. For *Boring or cutting out the ends of the Hubs of wheel carriages to receive the Boxes;* John B. Francis, Louden county, Virginia, March 2.

The hub to be bored is fixed within a sort of cage work composed of different pieces of iron adapted to the purpose of holding it centrically, and steadily, on a wooden frame. It is sustained upon this frame by making it the bearings for a cylindrical iron spindle which passes through the hub, and upon which it is capable of being turned round. For this purpose the spindle slides through holes in iron plates forming a part of what we have called the cage work, and into these holes the spindle fits accurately. By means of a mortise in the spindle, suitable cutters are fixed by wedging, or otherwise, which cutters are adapted in size and structure to the hole to be cut. When the respective parts are fixed in their proper places, the spindle is secured from turning round; the hub, or wheel, is then turned against the cutter, and the hole sunk to the proper depth.

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4. For a machine for *Hulling Clover Seed;* Christopher Seabold, jr. New Berlin, Union county, Pennsylvania, March 6.

A shaft about five feet long, is turned, for three and a half feet of its length, to a diameter of six inches, and then increasing in diame-

ter, along the remaining eighteen inches, to about eight inches. This shaft is made to revolve upon gudgeons in a suitable frame, but inclined from the horizon, the thicker end being the lowest. A spiral row of wooden pins is placed round the cylindrical part of the shaft, making three or four turns in its length. On the conical part of the shaft there are small steel pins, also driven spirally, but near together. A circular casing surrounds this shaft its whole length; that part of it in which the steel pins run is of sheet iron, punched to form a grater. The hopper is placed at the upper end of the casing, and as the shaft revolves the clover is carried within the casing by the wooden pins, until it arrives towards the other end, where it is operated upon by the apparatus described.

The claim is to the before described machine; and particularly to the spirally set pins for conveying the heads to the rubber, and the spirally set metal pins for rubbing it out.

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5. For a *Planing machine*, called the Horizontal Knife and Roller Plane; Uri Emmons, city of New York, March 6.

This machine, we are apprehensive, will not answer the purpose intended, unless the boards to be planed are first rived from trees perfectly straight in the grain; and even then we do not think that it would answer well. We shall be ready to retract the opinion thus expressed when a workman can be found who with a drawing knife can take a single shaving from end to end of a flooring board, and in this way leave it with a smooth finish.

The stuff to be planed is to pass between two iron rollers, either plain or fluted, the upper roller having on its ends iron fly wheels, which press it down on the board, and insure its feeding against the knife by which the planing is to be effected. The knife, or plane iron, is fixed exactly against the front of the upper feeding roller, extending along and cutting the whole width of the board at one operation. Cutting irons for tonguing and grooving are at the same time to act on its edges, and are at once to cut the tongue and the groove.

We do not think it necessary to describe the various accessory parts mentioned by the patentee, and figured in the drawing, as we have little doubt that those persons who have any knowledge upon the subject, will, from what we have already advanced, have arrived at the conclusion with which we commenced our remarks.

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6. For a *Machine for Moulding Bricks;* called "Drummond's Brick Moulder;" John Drummond, Whitestown, Oneida county, New York, March 6.

Without the aid of the engraver we cannot give an exact description of this machine, nor indeed are we aware that any thing further than a general idea of it is requisite. The prepared clay is put into a hopper, and the brick moulds placed upon a carriage, are forced, by means of a rack and pinion, under this hopper. As the brick moulds pass under, a row of rollers, seven in number, crossing the hopper near its bottom, and made to revolve by a band, forces the clay into the moulds. A wire, made to vibrate horizontally on the

upper surface of the moulds as they escape from the rollers, cuts off the superfluous clay, which is removed by a kind of scraper.

The use of the rollers, and the vibrating wire for cutting the superfluous clay from the mould, are the points relied on as new.

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7. For a *Medicine for the cure of Syphilis;* called "The Unfortunate's Friend;" Nicholas W. Bardean, city of New York, March 8.

In the first place a decoction is to be made by taking two pounds of liquorice root; of sarsaparilla root, guiacum, elder flowers, and raisins, each one pound; of mazereon root, burdock root, parsley root, and dried whortleberry leaves, each half a pound; putting them into four gallons of water, and reducing it to two by boiling. Into the warm, strained decoction, there is to be put of balsam copaiva and sweet spirits of nitre, each two pounds; of gum arabic, white sugar, cubebs and carbonate of soda, each one pound, and of gum opium one ounce.

This is the recipe, but it is given to us without any directions as to its exhibition. Should those who are so unfortunate as to be affected by the vile disease in question, depend for a cure upon the foregoing Friend, "Alas, poor Yorick!"

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8. For *Machinery for preparing Hides for Tanning;* Lewis Newsom, Gallipolis, Gallia county, Ohio, March 8.

There is to be a circular trough of about fifty feet in circumference, which is to be made of timber, and may be nine inches wide, and eight deep. A wheel of stone, or of wood, about four feet in diameter, is adapted to this trough by allowing it to revolve on the end of a horizontal lever, attached to a vertical shaft in the centre of the trough. Mills of this description are well known; and, as the patent is for the machinery employed, this ought to have some novelty.

Hides intended for tanning are to be softened in the trough, and those which have been limed are to have the lime worked out in it, preparatory to their going into the first bark liquor. When hides are to be put into the vats they are to be fastened to frames made for the purpose, on which they can be hooked; these frames are lowered into, or raised from the vats, by means of suitable tackle.

Hides have been suspended and lowered in similar ways, and the modes of effecting it have been made the subjects of patents.

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9. For an improvement in *Harness Saddle Trees;* Philo Washburn, Bristol county, Massachusetts, March 8.

This saddle tree is to be made entirely of wrought iron. In the middle, where it is fitted to the ridge of the horse's back it is to be made quite narrow, whilst the sides are widened and flattened out. The terrets and water hook screw into holes prepared for them, and the tree, when properly padded, is complete. The claim is to the wrought iron tree, as a substitute for wood, it being more compact and stronger than that material.

10. For a *Machine for cutting Sausage Meat;* John Brannan, city of Baltimore, March 8.

The whole description of this machine, including the claim, extends to nine lines only, but as these refer to a drawing, we shall be obliged to be somewhat more prolix. The sausage meat is put into a round tub, or trough, which is to revolve on an axis. A horizontal axis above the tub carries a double crank and pitmen, which work knives up and down within the tub. These knives are kept in motion by turning a winch, or handle, on the shaft of which there is a cog wheel taking into a pinion on the crank shaft; and a vertical shaft, turned by an endless screw, on the horizontal one, has a pinion on its lower end, which, mashing into cogs surrounding the tub, causes it to revolve. The claim is to this last part of the apparatus. There is some slight difference in the mode in which this tub is made to revolve, and that of others which have received a similar motion, but in the principle of the machine there is nothing new, and its variation from others can scarcely be called an improvement.

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11. For *Rail-ways and Cars used thereon;* Jedediah Richards, Elbridge, Onondaga county, New York, March 9.

The rail-way is to be a single rail, sustained by suitable supports. Two wheels, in a frame made for the purpose, are to run on this rail, the car being suspended under it by iron rods attached to the frame of the wheels.

The claim is "to the before described improvements in rail-ways, and in the cars or carriages used thereon."

Single suspension rails were patented in England by Mr. H. R. Palmer, six or seven years ago, and are described in this journal for April, 1828; they, however, have never been brought into practical use. There is but little difference between the present plan and that proposed by Mr. Palmer; the principle of both is the same, and we do not think that Mr. Richards has made any improvement on that first suggested, nor has he alluded to it, but has taken his patent as though single rails were absolutely new.

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12. For a *Mill for Grinding Apples and Potatoes,* and for shelling corn; Edmund Harris, James Newton, Willard Webster, and Jehiel W. Dart, Truxton, Courtland county, New York, March 10.

A spindle, running vertically, carries the runner of this mill, which is a stone made hemispherical, or more or less curved above, but flat beneath. The cap stone is hollowed, like a bowl, to adapt it to the curvature of the lower stone, and has an eye in it for the spindle to pass through, and also for feeding.

"The invention claimed is the grinding apples, potatoes, and shelling corn, as above described, with stone, and in the cheapness and durability of the mill."

Whatever may be the merits of this mill, its claim to novelty is a very slender one; the contribution of each of the four inventors must

in fact be so minute as to be almost invisible, although it seems that there was "quite enough to swear by."

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13. For a machine for *Making Crackers, Ship Bread, &c.;* John Bruce and Charles Bruce, Brooklyn, King's county, New York, March 13.

A long sliding table, or platform, is to be fixed upon a suitable stand, or frame, with ledges to guide it, and cause it to slide forward and backward in a direct line. Upon this table the dough to be formed into crackers, ship bread, &c. is to be rolled out. There are three rollers, or cylinders, the gudgeons of which run in cheeks rising from the frame on each side of the platform, and having their axes nearly in the same horizontal plane, but not precisely so, the roller with which the dough first comes into contact being farther from the platform than the second, and the third, or last, being still nearer than the second, its distance being such as to reduce the dough to the thickness required. The first roller is turned by a crank, and on its ends are toothed wheels which take into the teeth of racks on each edge of the platform, thus forcing it to advance.

There is a fourth cylinder, called the cutting cylinder, which crosses the platform immediately in front of the last roller. This cylinder is surrounded with circular, or other formed, cutters, the edges of which extend down to the platform. Within each of the cutting moulds there may be docking points, a die with a name, &c. A plate, nearly filling the inside of the mould, and perforated, when necessary, to accommodate the dockers, is borne forward by spiral, or other springs, to force the cut cracker, &c. out of the mould.

The claims are to "the use of two or more cylindrical rollers successively, to reduce the dough to its desired thickness, in connexion with the aforesaid cutting cylinder; the use of the aforesaid cutting cylinders containing cutters of the ordinary description, whether it be so constructed as to make circular biscuits, or the same, or similar articles, of any other shape or form whatever."

We refer those who are interested in the subject of machines for manufacturing crackers, to the several patents for apparatus for that purpose, which we have formerly noticed. On comparing the description and claims above specified with those of Clark & Henderson, vol. vi. p. 302, and Fairbanks & Dunott, vol. viii. p. 343, we think it will appear that a considerable portion of the ground claimed by the present patentees, is such as has been previously occupied.

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14. For an improvement in the *Manner of supplying Steam Boilers;* Jesse Fox, Lowell, Middlesex county, Massachusetts, March 14.

Those who are well acquainted with the different modes which have been adopted for supplying boilers with water, know that it is sometimes done by causing a cylinder, or a conical plug, to revolve in a suitable case, like the key of a cock in its socket, and having at

one point, a cavity within it, which as it turns, is filled with water from a reservoir above it, and in its revolution delivers it therefrom into the boiler. The plan before us is of this character, but in the structure and arrangement of its parts appears to be new, and well conceived; without the aid of a plate, however, we can attempt no more than a very general description of it.

The revolving piece which has the cavities in it for the reception and supply of water, is a cylinder of iron four inches and a half in diameter, and one and a half in thickness; this cylinder revolves on a suitable axis, being enclosed for more than half its circumference in a casing, which is furnished with a flanch, by which the apparatus is attached to a boiler. A hole is made in the boiler to admit a projecting part of the revolving supply wheel, which is nearly equal to one-half of it. This wheel is perforated on opposite sides, so as to remove nearly one half of its substance. Imagine it to be divided into four parts, or quadrants, the part removed consists of two opposite quadrants, leaving a rim, however, of one-fourth of an inch in thickness at the outside, and an equal portion round the gudgeon at the centre. These cavities, as the wheel revolves, are alternately exposed to the pressure of water in a reservoir from which they are filled, and to the inside of the boiler, into which the water falls from them, both sides of the wheel being equally acted upon by the steam.

The perforation of the boiler is at the point intended for the water line, in order that the tendency of the wheel may be to carry back as much as it supplies when the boiler is sufficiently full. The claim is to the apparatus as described.

A principal objection to revolving wheels of this description is their gradual wear, which, although they may operate satisfactorily at first, soon unfits them for the duty they are to perform. Should this objection be removed, the principle is undoubtedly a good one.

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15. For a *Washing Machine;* Noah Morrison and John Lewis, Union Town, Fayette county, Pennsylvania, March 14.

This is called the "horizontal, double dasher, washing and scouring machine.

A trough has a shaft crossing it near its centre, and carrying two cranks; pitmen from these cranks cause two sliding dashers to traverse in the trough in opposite directions, and to squeeze between them and a breasting prepared for the purpose, the clothes put in at either end of the machine.

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16. For a *Mill for grinding Paints;* Oliver C. Harris, Sangerfield, Oneida county, New York, March 15.

On the upper part of a suitable frame a circular hopper, or curb, is placed; it is made of cast iron, and is to receive the paint to be ground. The lower part of this hopper is made conical to receive from below the runner, or nut, formed like that of the common coffee mill, this is also of cast iron, and has a shaft, or spindle, by which it

is to be turned, extending down to a bridge tree. There is an elastic scraper bearing against the under rim of the runner to scrape off the paint. The edges of the runner and of the hollow cone are to have teeth on them; and the shaft, or spindle, is to be turned by a crank carrying a toothed wheel, taking into a pinion on the shaft.

There is no claim made, which we think is just as it should be, obviating a great difficulty by saying nothing about novelty.

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17. For a *Faucet for drawing Liquids;* called Goodyear's spring and lever faucet; Charles Goodyear, city of Philadelphia, March 16.

These faucets, or cocks, have nearly the same external form with the block-tin cocks in common use; but instead of the screw plug in them, or the revolving key of the common cock, they are opened by raising a valve perpendicularly, which is kept down in its place by means of a spiral spring. The exterior end of the cock is a hollow vertical cylinder, the top of which is closed by a cap, whilst the lower end is left open. A rim or shoulder surrounds this lower end, rendering the opening smaller than the cylindrical barrel above it, and upon this shoulder the valve rests. The valve is a circular disk of metal, on to the lower side of which there is a tube that forms the spout, or adjutage of the cock; this tube fits exactly into the rim upon which the valve rests, and when the valve is raised a part of this tube slides up into the cylindrical chamber. A perforation is made in the side of the tube, which, when it is thus raised, allows the liquor from the shank of the cock to flow through it. A spiral spring, extending from the cap of the chamber, on to the top of the valve, keeps it in its seat. The valve is raised by two wires which descend from the top of the chamber, at the outside, and opposite to each other, and are fastened below into ears projecting from the tube. These wires are connected at the top, and when raised are acted upon by a small lever; and to keep them in their proper places and cause them to rise vertically, they slide through holes in projecting rims made for that purpose.

The claim is to the application of a spiral spring to a valve in the manner described.

A cock so constructed will undoubtedly operate very well, but the spiral spring being constantly surrounded by the liquor, will, we apprehend, be liable to corrosion by some liquids, or to be furred up by others.

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18. For a *Silk Reel,* for reeling silk from cocoons; Eliphalet Snow, Mansfield, Tolland county, Connecticut, March 6.

The silk reel is a very simple instrument, and although it has been made in various forms, its essential parts are the same. The present patentee has described his own form of reel, but without telling what particular advantages it possesses over others, or claiming any part as new. As we are unable to supply these deficiencies, we shall not attempt to follow him in his description.

19. For a *Revolving Lath Cutter;* Simon Willard, Cincinnati, Hamilton county, Ohio, March 16.

A cylinder, which, for laths of the ordinary length, may be about five feet in diameter, and of the length of the lath, is made to revolve on a strong iron shaft. The ends of the cylinder are best made of cast iron, as the whole machine must have great strength and weight. The periphery of the cylinder is of wood, and turned perfectly true; one or more cutters, formed of strong flat iron bars, faced with steel, extend from end to end of the cylinder, the distance from which to the cutting edge forms the gauge for the thickness of the lath. A horizontal bar of wood, having on it one of iron, serves as a rest upon which the timber to be cut is held. The edge of the board, held upon the rest, is forced up against the face of the cylinder, whilst the latter is revolving. The width of the lath is determined by the thickness of the board used.

There are several accessory parts, such as a revolving apron, or other contrivances, for carrying off, and collecting together, the laths, but these we do not think it necessary to describe.

The claim is to the combination of revolving cutters, a cylinder, and other machinery, as described, for the purpose of cutting laths.

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20. For a *Smoke Ventilator;* Silas Smith, Hamilton, Butler county, Ohio, March 17.

This smoke ventilator is a modification of the well known valve, or damper, employed to open or close the throat of a chimney. Its distinguishing feature consists in making the sloping back of the fire place of cast iron, and fixing it so that it will work upon hinges, or pivots, at bottom. This is to be altered in its slope by means of endless screws fixed near its upper part. When brought forward, it closes the throat in any desired degree. The upper part of this moveable plate curves back, to favour the exit of the smoke, and to form a mechanical obstruction to a downward draft.

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21. For *Machinery for Printing;* John Hatch, Boston, Massachusetts, March 21.

This is a new contribution to the list of power presses, the introduction of which has done so much in facilitating the typographic art. In a complex machine of this description, the parts are too numerous, and the peculiar combination which constitutes the essential characteristics of a new or improved machine, too dependent upon minute points to admit of their being given without drawings. To such particulars the claims made by the present patentee refer, and we therefore dismiss the subject, at present, without an attempt at description.

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22. For a *Thrashing Machine;* Abel Lock and William Coleman, jr., Frederick city, Frederick county, Maryland, March 21.

This machine is described with much brevity, and makes no pretention to novelty. We are told that there is in the first place a

suitable frame; in the second, a hopper or revolving apron for feeding; in the third, a hollow revolving cylinder, the perimater being made of plates of iron, passing spirally from head to head, and carrying projections, or teeth; and fourthly, a concave bed with similar teeth. Having said thus much, the patentees sign their names, and take their leave.

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23. For a *Clothes Line Vice;* Samuel Pryor, Salem, Salem county, New Jersey, March 22.

A strip of hickory, about six inches long, is to be bent in the middle, so as to bring the two ends parallel to each other, forming a clamp about two and a half inches long. A wooden screw is made to draw these together, and the machine is then prepared to hold clothes upon lines whilst drying.

We do not think that this patented instrument is, upon the whole, superior to the common clamp, as it will, when caught in a shower, or otherwise exposed to wet, be found to swell, and this will interfere with the working of the screw.

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24. For a *Shingle Cutting Machine*; George Wolf, Clear Creek, Fairfield county, Ohio, March 22.

It appears, so far as we can collect from an obscure description, and a still worse drawing, that knives are to be set in a stock, which stock is to be made to traverse against the block by a crank motion. Such machines are quite common, and have but little merit, performing the work very imperfectly.

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25. For an improvement in the *Saw Mill;* Vachel Blaylock, Bellefontaine, Logan county, Ohio, March 24.

N. B. The word improvement, when applied to patents, is not by any means to be taken in its ordinary acceptation, as in numerous instances it means any thing rather than the rendering of a machine better than it was previously. In a patent dictionary the definition which would most generally apply would be *alteration*, as this would include both the mending and the marring of any such article as may be altered.

This improved saw mill is to be moved by the power of a horse, kept walking in a circle, and thereby turning a vertical shaft in the common and long approved way. A wheel on the lower end of the vertical shaft, gears into one on a horizontal shaft, which is to be so covered as to allow the horse to walk over it. This horizontal shaft carries a vertical spur wheel eight feet in diameter, which turns two pinions, the shafts of which run on bearings in suitable supports. According to one part of the specification there are to be cranks on the far ends of these pinion shafts, each carrying a saw frame; but according to another part there are to be cams upon each of the pinion shafts, operating on the opposite ends of a lever having a fulcrum in its centre, and made to vibrate like a scale beam by the action of these cams on its lower side; the drawing seems to confirm this lat-

ter structure as the approved one. The ends of this lever are employed as substitutes for cranks in operating upon saw frames. The whole gearing as described, with the addition of the friction of the cams, acting in the way shown in the drawing, will add a liberal percentage to the necessary friction, and prevent all danger of the horses employed suffering from dyspepsia if labour will prevent that disease.

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26. For a *Bark Mill;* Daniel Humberd and George Downs, M'Connelstown, Bedford county, Pennsylvania, March 27.

The claim made by these patentees is to "the before described machine or mill for grinding bark," adding "we make no claim to the runner and bed." What they call the runner and bed, is the common cast iron bark mill. The shaft of this is to be turned by animal power in the common way, a horizontal cog wheel giving motion to a trundle head on the shaft of the mill. A circular trough, or curb, is to catch the bark as it falls, and prevent it from scattering.

It is quite plain from the foregoing that the patentees imagine that it is the patent, and not the originality of the thing patented, which gives the right, as there is not the slightest pretension made by them to the invention of any thing, nor the slightest room to urge such a pretension.

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27. For an improvement in the construction of *Backs for Forges* and other fires; Philo C. Curtis, Utica, Oneida county, New York, March 27.

This forge back is a box made of cast iron, about twelve inches long and ten high, and it has a depth from the fire back of about six inches. The object proposed is to supply this box with wind in such a way as to blow heated air into the fire, whilst that side of it which is in contact with the fire shall be preserved from burning out.

The box is cast in two parts, capable of being put together so as to be air tight. The wind from the bellows passes in at one end of it, and escapes into the fire through a hole in the front plate, which forms the forge back. There is a centre plate, twelve inches long and ten high, which is put into the box, dividing it into two chambers; this centre plate is perforated with numerous small holes, and has one of a larger size corresponding with the hole in the front plate; the tube, or tuyere, which conducts the wind to the fire, fits into both these holes, so that all the wind must come from the posterior chamber, whilst the wind from the bellows passes into the anterior chamber.

The operation will now be readily understood. The wind which passes into the anterior chamber, having to pass through the small holes in the centre plate, before it can arrive at the tuyere, and coming into contact with the heated plate which forms the forge back, becomes itself heated, and in becoming so cools the front plate.

The patentee says that a considerable portion of coal is saved by thus using heated air. On this subject we refer our readers to p. 339

of the last volume, where the advantage of supplying a furnace with heated air is particularly noticed.

The claim in the present case is to applying wind from the bellows against the back of a plate exposed to the fire, and also to the particular mode of so doing, as explained in the specification.

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28. For an improvement in the *Mode of Spinning Wool*, for the manufacture of coarse or heavy fabrics, and particularly for ingrain carpeting; William Calvert, Royal Southwick, and Alfred Messinger, Lowell, Middlesex county, Massachusetts. The former an alien, having resided here two years; the two latter citizens of the United States. March 31.

The machine here patented is well represented in the drawing, and explained with sufficient clearness in the specification; still the parts which are new are not designated, but left to be inferred by those acquainted with such machinery. This does not fulfil the requirements of the law, yet we presume that by a liberal construction of it, the rights of the patentees might be sustained.

The patentees state that this machine resembles those in general use for spinning worsted and cotton; but that from placing the rollers nearer together than in worsted machinery, and making them larger than in that for cotton, it produces yarn which could not be obtained from either of them.

The wool is taken from the carding condenser on to a feeding cylinder, whence it passes through all the rollers, of which there are three pair; two being small, and placed between the ordinary drawing rollers. The feeding cylinder, it is said, has never before been applied to the throstle frame.

The difference in the mode of spinning from that in other machines is that it is effected by a continuous motion; the thread being wound on the bobbins, or spools, as fast as the roping is discharged from the rollers, the rollers not stopping, as in the common machines, whilst the roping is drawn and twisted.

It is averred that three times the ordinary quantity may be spun by one of these machines; six spindles producing as much as eighteen have heretofore done.

The quality of the yarn is said to be much improved, the fibres being drawn nearly straight, as in worsted. Several other advantages are enumerated by the inventors, who have taken much more pains to inform us what the machine does, than how it accomplishes its work. Patentees are often anxious to make known in their specifications the utility of their inventions, a point which may be omitted altogether without any disadvantage, the main question being that of novelty.

## Analysis of the Report, &c. on Steam Carriages.

*Report on Steam Carriages by a Committee of the House of Commons of Great Britain. With the minutes of Evidence, and Appendix. Reprinted by order of the House of Representatives of the United States.* (1832.)*

We are indebted to this reprint of the report on steam carriages, by a committee of the House of Commons of England, for the means of placing before our readers the results of a most interesting investigation into the progress made in the attempts at locomotion, by steam carriages, upon common turnpike roads.

In this country was made the first successful attempt to move a carriage, upon a common road, by steam power applied to give rotation to the wheels. In the year 1804 the dredging machine of Oliver Evans was propelled by the adhesion of its wheels from Broad street to the Schuylkill, and the engine of the machine was further used to propel, by a paddle wheel, the scow in which it was placed, down the Schuylkill, and up the Delaware, to the station where it was to be used.

It may be yet some time before the ingenuity of our countrymen is turned to the application of steam power which we are about to consider: our roads must be more or less improved both in relation to their longitudinal and to their transverse section. To induce this expense, an amount of travelling must be secured, between our inland towns, not likely to take place for some time. The magnificent water courses which facilitate our communication between the large cities on the Atlantic board, and between the growing towns of the west, have led to the acknowledged superiority which we enjoy over our transatlantic brethren (the English,) in the application of steam to navigation: our extent of territory, and the sparseness of its population have been strong inducements to a devoted attention to this subject. The peculiar facilities of rail-road communication between vast commercial and manufacturing depots, has caused England to precede us very far in that mode of communication, and, consequently, in the application of steam power to locomotion upon rail-ways. Until steam coaches shall have been made to travel upon common roads at a more rapid rate than our combined water and land communications can enable us to attain, thereby to shorten the time of passage between some of our large cities, we can hardly expect that this species of locomotion will receive much of the attention of the public. By keeping up with the state of information in England upon this subject, we shall always be prepared to take advantage of a proper opening for the introduction of such a mode of communication, with the advantage of the experience which might otherwise have been dearly bought. No doubt there are portions of our better roads which might be made available, for a short distance, for profitable speculation in this new sort of locomotion.

Much of the evidence before the committee of the House of Com-

* Com. Pub.

mons is of local interest merely, and many of the statements would find no application with us: a part even of the report of the committee might, perhaps, have been omitted, or have been condensed, without injury to the interests of our readers; we have, however, preferred to insert it unmutilated.

The inquiry with which this committee was charged grew out of representations made by those interested in the new application of steam to locomotion, in relation to the heavy tolls imposed upon their carriages on the different turnpikes. The subject, as referred to the committee, took, however, a wider range than that of a mere inquiry in relation to the tolls. The objects of examination were, first, in relation to the tolls which ought to be imposed upon coaches and other vehicles propelled by steam or gas upon turnpike roads, together with the tolls at present imposed; second, in relation to the present state and future prospects of this application to locomotion upon common roads, with the probable utility resulting to the public from such an application.

We purpose first to give the report of the committee, and afterwards, by extracts from the minutes of evidence, and condensed views of the more interesting parts of it, to put our readers in possession of the material facts developed in the examination.

*Report of the Committee on Steam Carriages.* CHARLES D. O. JEPHSON, *Chairman.*

"The committee proceeded, in the first instance, to inquire how far the science of propelling carriages on common roads by means of steam or mechanical power, had been carried into practical operation; and whether the result of the experiments already made had been sufficiently favourable to justify their recommending to the House that protection should be extended to this mode of conveyance, should the tolls imposed on steam carriages, by local acts of parliament, be found prohibitory or excessive.

"In the progress of their inquiry, they have extended their examination to the following points, on which the chief objections to this application of steam have been founded, viz.—the insecurity of carriages so propelled, from the chance of explosion of the boiler, and the annoyance caused to travellers, on public roads, by the peculiar noise of the machinery, and by the escape of smoke and waste steam, which were supposed to be inseparable accompaniments.

"It being also in charge to the committee, 'to report upon the proportion of tolls which should be imposed upon steam carriages,' they have examined several proprietors of those already in use, as to the effect produced on the surface of roads by the action of the propelling wheels.

"As this was too important a branch of their inquiry to rest entirely on the evidence of individuals, whose personal interest might have biassed their opinions, the committee also examined several very scientific engineers, by whose observations, on the causes of the ordinary wear of roads, they have been greatly assisted.

"The committee were directed also to report 'on the probable utility which the public may derive from the use of steam carriages.' On this point they have examined a member of the committee, well known for his intelligence and research on subjects connected with the interests of society, and they feel that they cannot fulfil this part of their instructions better than by merely referring the house to the evidence of Colonel Torrens.

"These inquiries have led the committee to believe that the substitution of inanimate for animal power, in draught on common roads, is one of the most

important improvements in the means of internal communication ever introduced. Its practicability they consider to have been fully established; its general adoption will take place more or less rapidly, in proportion as the attention of scientific men shall be drawn, by public encouragement, to further improvement.

"Many circumstances, however, must retard the general introduction of steam as a substitute for horse power on roads. One very formidable obstacle will arise from the prejudices which always beset a new invention, especially one which will at first appear detrimental to the interests of so many individuals. This difficulty can only be surmounted by a long course of successful, though probably unprofitable experiment. The great expense of the engines must retard the progress of such experiments. The projectors will, for a long period, work with caution, fearing not only the expense incurred by failure, but also that too sudden an exposure of their success would attract the attention of rivals. It is difficult to exemplify to the house how small and apparently unimportant an adaptation of the parts of the machinery, or of the mode of generating or applying the steam, may be the cause of the most rapid success; yet he who, by a long course of experiments, shall have first reached this point, may be unable to conceal the improvement, and others will at once reap the benefit of it.

"The committee are convinced, that the real merits of this invention are such, that it may be safely left to contend with these and similar difficulties; there are others, however, from which the legislature can alone relieve it. Tolls, to an amount which would utterly prohibit the introduction of steam carriages, have been imposed on some roads; on others, the trustees have adopted modes of apportioning the charge which would be found, if not absolutely prohibitory, at least to place such carriages in a very unfair position as compared with ordinary coaches.

"Two causes may be assigned for the imposition of such excessive tolls upon steam carriages. The first a determination on the part of the trustees, to obstruct, as much as possible, the use of steam as a propelling power; the second, and probably the more frequent, has been a misapprehension of their weight and effect on roads. Either cause appears to the committee a sufficient justification for their recommending to the house, that legislative protection should be extended to steam carriages with the least possible delay.

"It appears from the evidence that the first extensive trial of steam as an agent in draught on common roads, was that by Mr. Gurney, in 1829, who travelled from London to Bath, and back, in his steam carriage. He states, that although a part of the machinery which brings both the propelling wheels into action when the full power of the engine is required, was broken at the onset, yet that, on his return, he performed the last eighty-four miles, from Melksham to Cranford bridge, in ten hours, including stoppages. Mr. Gurney has given to the committee very full details of the form and power of his engine, which will be found in the evidence.

"The committee have also examined Messrs. Summers and Ogle, Mr. Hancock, and Mr. Stone, whose steam carriages have been in daily use for some months past on common roads. It is very satisfactory to find that, although the boilers of the several engines described, vary most materially in form, yet that each has been found fully to answer the expectation of its inventor. So well, in fact, have their experiments succeeded, that in each case where the proprietors have ceased to use them, it has only been for the purpose of constructing more perfect carriages, in order to engage more extensively in the business.

"When we consider that these trials have been made under the most unfavourable circumstances—at great expense—in total uncertainty—without any of those guides which experience has given to other branches of engineering—that those engaged in making them are persons looking solely to their own interests, and not theorists attempting the perfection of ingenious models—when

we find them convinced after long experience, that they are introducing such a mode of conveyance as shall tempt the public, by its superior advantages, from the use of the admirable lines of coaches which have been generally established—it surely cannot be contended that the introduction of steam carriages on common roads is, as yet, an uncertain experiment, unworthy of legislative attention.

"Besides the carriages already described, Mr. Gurney has been informed that from 'twenty to forty others are being built by different persons, all of which have been occasioned by his decided journey in 1829.'

"The committee have great pleasure in drawing the attention of the house to the evidence of Mr. Farey. His opinions are the more valuable from his uniting, in so great a degree, scientific knowledge to a practical acquaintance with the subject under consideration. He states that he has 'no doubt whatever but that a steady perseverance in such trials will lead to the general adoption of steam carriages:' and again, 'that what has been done proves to his satisfaction the practicability of impelling stage coaches (by steam,) on good common roads, in tolerably level parts of the country, without horses, at a speed of eight or ten miles per hour.'

"Much, of course, must remain to be done in improving their efficiency; yet Mr. Gurney states that he has kept up steadily the rate of twelve miles per hour; that 'the extreme rate at which he has run is between twenty and thirty miles per hour.'

"Mr. Hancock 'reckons that, with his carriage he could keep up a speed of ten miles per hour, without injury to the machine.'

"Mr. Ogle states 'that his experimental carriage went from London to Southampton, in some places, at a velocity of from thirty-two to thirty-five miles per hour.'

"'That they have ascended a hill rising one in six, at sixteen and a half miles per hour, and four miles of the London road at the rate of twenty-four miles and a half per hour, loaded with people.'

"'That his engine is capable of carrying three tons weight, in addition to its own.'

"Mr. Summers adds, 'that they have travelled in the carriage at the rate of fifteen miles per hour, with nineteen persons on the carriage, up a hill one in twelve.'

"'That he has continued for four miles* and a half, to travel at the rate of thirty miles per hour.'

"'That he has found no difficulty of travelling over the worst and most hilly roads.'

"Mr. James Stone states that 'thirty-six persons have been carried on one steam carriage.'

"'That the engine drew five times its own weight nearly, at the rate of from five to six miles per hour, partly up an inclination.'

The several witnesses have estimated the probable saving of expense to the public, from the substitution of steam power for that of horses, at from one-half to two-thirds. Mr. Farey gives as his opinion, 'that steam coaches will, very soon after their first establishment, be run for one-third of the cost of the present stage coaches.'

"Perhaps one of the principal advantages resulting from the use of steam, will be, that it may be employed as cheaply at a quick as at a slow rate; 'this is one of the advantages over horse labour, which becomes more and more expensive as the speed is increased. There is every reason to expect that, in the end, the rate of travelling by steam will be much quicker than the utmost speed of travelling by horses; in short, the safety to travellers will become the limit to speed.' In horse draught the opposite result takes place; 'in all cases horses

* In the original, "hours:" Mr. Summers states this to be a mistake, and directs the substitution which we have made.—Mech. Mag. March 1832, p. 443.

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lose power of draught in a much greater proportion than they gain speed, and hence the work they do becomes more expensive as they go quicker.' On this and other points referred to in the report, the committee have great pleasure in drawing the attention of the house to the valuable evidences of Mr. Davies Gilbert.

"Without increase of cost, then, we shall obtain a power which will insure a rapidity of internal communication far beyond the utmost speed of horses in draught; and although the performance of these carriages may not have hitherto attained this point, when once it has been established, that at equal speed we can use steam more cheaply in draught than horses, we may fairly anticipate that every day's increased experience in the management of the engines, will induce greater skill, greater confidence, and greater speed.

"The cheapness of the conveyance will probably be for some time a secondary consideration. If at present it can be used as cheaply as horse power, the competition with the former modes of conveyance will first take place as to speed. When once the superiority of steam carriages shall have been fully established, competition will induce economy in the cost of working them. The evidence, however, of Mr. Macneil, showing the greater efficiency, with diminished expenditure of fuel, by locomotive engines on rail-ways, convinces the committee that experience will soon teach a better construction of the engines, and a less costly mode of generating the requisite supply of steam.

"Nor are the advantages of steam power confined to the greater velocity attained, or to its greater cheapness than horse draught. In the latter, danger is increased, in as large a proportion as expense, by greater speed. In steam power, on the contrary, 'there is no danger of being run away with, and that of being overturned is greatly diminished. It is difficult to control four such horses as can draw a heavy carriage ten miles per hour, in case they are frightened or choose to run away; and for quick travelling they must be kept in that state of courage, that they are always inclined for running away, particularly down hills and at sharp turns of the road. In steam, however, there is little corresponding danger, being perfectly controllable, and capable of exerting its power in reverse in going down hills.' Every witness examined has given the fullest and most satisfactory evidence of the perfect control which the conductor has over the movement of the carriage. With the slightest exertion it can be stopped or turned, under circumstances where horses would be totally unmanageable.

"The committee have, throughout their examinations, been most anxious to ascertain whether the apprehension very commonly entertained, that an extensive use of these carriages on roads would be the cause of frequent accidents and continued annoyance to the public, were well founded.

"The danger arising from the use of steam carriages, was stated to be twofold; that to which passengers are exposed from explosion of the boiler, and the breaking of the machinery, and the effect produced on horses by the noise and appearance of the engine.

"Steam has been applied as a power in draught in two ways: in the one, both passengers and engine are placed on the same carriage; in the other, the engine carriage is merely used to draw the carriage in which the load is conveyed. In either case, the probability of danger from explosion has been rendered infinitely small, from the judicious construction of boiler which has been adopted.

"These boilers expose a very considerable surface to the fire, and steam is generated with the greatest rapidity. From their peculiar form, the requisite supply of steam depends on its continued and rapid formation; no large and dangerous quantity can at any time be collected. Should the safety valve be stopped, and the supply of steam be kept up in a greater abundance than the engines require, explosion may take place, but the danger would be comparatively trifling, from the small quantity of steam which could act on any one portion of the boiler. As an engine, invented by Mr. Trevithick, has not been as yet

applied to carriages, the committee can do no more than draw the attention of the house to the ingenuity of its contrivance. Should it in practice be found to answer his expectation, it will remove entirely all danger from explosion. In each of the carriages described to the committee, the boilers have been proved to a considerably greater pressure than they can ever have to sustain.

"Mr. Farey considers that 'the danger of explosion is less than the danger attendant on the use of horses in draught; that the danger in these boilers is less than in those employed on the railway, although there even, the instances of explosion have been very rare.' The danger arising to passengers from the breaking of the machinery, need scarcely be taken into consideration. It is a mere question of delay, and can scarcely exceed in frequency the casualties which may occur with horses.

"It has been frequently urged against these carriages, that wherever they shall be introduced, they must effectually prevent all other travelling on the road, as no horse will bear quietly the noise and smoke of the engine.

"The committee believe that these statements are unfounded. Whatever noise may be complained of, arises from the present defective construction of the machinery, and will be corrected as the makers of such carriages gain greater experience. Admitting even that the present engines do work with some noise, the effect on horses has been greatly exaggerated. All the witnesses accustomed to travel in these carriages, even on the crowded roads adjacent to the metropolis, have stated that horses are very seldom frightened in passing. Mr. Farey and Mr. Macneil have given even more favourable evidence in respect to the little annoyance they create.

"No smoke need arise from such engines. Coke is usually burned in locomotive engines, on rail-ways, to obviate this annoyance; and those steam carriages which have been hitherto established also burn it. Their liability to be indicted as nuisances will sufficiently check their using any offensive fuel.

"There is no reason to fear that waste steam will cause much annoyance. In Mr. Hancock's engine it passes into the fire, and in other locomotive engines it is used in aid of the power, by creating a quicker draught and more rapid combustion of the fuel. In Mr. Trevithick's engine it will be returned into the boiler.

"The committee not having received evidence that gas has been practically employed in propelling carriages on common roads, have not considered it expedient to inquire as to the progress made by several very scientific persons who are engaged in making experiments on gases, with the view of procuring a still cheaper and more efficient power than steam.

"The committee having satisfied themselves that steam has been successfully adopted as a substitute for horse power on roads, proceeded to examine whether tolls have been imposed on carriages thus propelled, so excessive as to require legislative interference, and also to consider the rate of tolls by which steam carriages should be brought to contribute, in fair proportion with other carriages, to the maintainance of the roads on which they may be used.

"They have annexed a list of those local acts in which tolls have been placed on steam, or mechanically propelled carriages.

"Mr. Gurney has given the following specimens of the oppressive rates of tolls adopted in several of these acts: On the Liverpool and Prescot road, Mr. Gurney's carriage would be charged £2 8s. while a loaded stage coach would pay only 4s. On the Bathgate road the same carriage would be charged £1 7s. 1d., while a coach drawn by four horses would pay 5s. On the Ashburnham and Totness road Mr. Gurney would have to pay £2, while a coach drawn by four horses would be charged only 3s. On the Teignmouth and Dawlish roads the proportion is 12s. to 2s.

"Such exorbitant tolls on steam carriages can only be justified on the following grounds:

"First, because the number of passengers conveyed on, or by, a steam carriage will be so great as to diminish (at least the extent of the difference of the

rate of toll,) the total number of carriages used on the road; or, secondly, because steam carriages induce additional expense in the repairs of the road.

"The committee see no reason to suppose that, for the present, the substitution of steam carriages, conveying a greater number of persons than common coaches, will take place to any very material extent; and, as to the second cause of increased charge, the trustees, in framing their tolls, have probably not minutely calculated the amount of injury to roads likely to arise from them.

"The committee are of opinion that the only ground on which a fair claim to toll can be made on any public road, is to raise a fund which, with the strictest economy, shall be just sufficient, first, to repay the expense of its original formation; secondly, to maintain it in good and sufficient repair.

"Although the committee anticipate that the time is not far distant when, in framing a scheme of toll for steam carriages, their general adoption, and the great number of passengers which will be conveyed on a small number of vehicles, will render it necessary not only to consider the amount of injury actually done to the road, but also the amount of debt which may have been incurred for its formation and maintenance; yet at present they feel justified by the limited number of such carriages, and by the great difficulties they will have to encounter, in recommending to the house, that in adopting a system of toll, the proportion of 'wear and tear' of roads by steam, as compared with other carriages, should alone be taken into consideration.

"Unless an experiment were instituted on two roads, the one reserved solely for the use of steam coaches, the other for carriages drawn by horses, for the purpose of ascertaining accurately the relative wear of each, it would be quite impossible to fix with certainty the proportion of tolls to which, on the same road, each class of vehicles should be liable. To approximate, however, as nearly as possible to the standard of relative wear, the committee have compared the weights of steam carriages with those of loaded vans and stage coaches. They have tried to ascertain the causes of the wear of roads; also the proportion of injury done by the feet of horses and the wheels of coaches; how far that injury is increased by increased velocity, and also in what degree the wear of roads by loaded carriages may be decreased by any particular form of wheel.

"The committee would direct the attention of the house especially to the evidence of Mr. Macneil, whose observations on this branch of the subject, being founded on a long course of very accurate experiment, are peculiarly interesting and useful. He estimates that the feet of horses drawing a fast coach, are more injurious to the road than the wheels, in the proportion of three to one, nearly; that this proportion will increase with the velocity; that by increasing the breadth of the tires of the wheels, the injury done to roads by great weights may be counteracted. He considers that, on a good road, one ton may be safely carried on each inch of width of tire of the wheels.

"Mr. M'Adam and Mr. Telford have given corresponding evidence as to the greater wear caused by horses' feet, than by wheels of carriages.

"Each of the above witnesses agrees, that adding the weight of the horses to that of the coach, and comparing the injury done to a road by a steam carriage of a weight equal to that of the coach and horses, (the wheels being of a proper width of tire,) the deterioration of the road will be much less by the steam carriage than by the coach and horses.

"As to the injury to roads which is anticipated from the 'slipping' of the wheels, it may safely be left to the proprietors to correct: the action of the wheel slipping involves a waste of power, and a useless expenditure of fuel, which, for their own sakes, they will avoid.

"Apprehension has also been entertained that, although the peculiar action of the wheels may not be injurious, yet that, from the great power which may be applied if the steam were worked at very high pressure, or if the size of the engine were increased, greater weight might be carried than the strength of the road could bear.

"Undoubtedly, in proportion to the advance of the science, will be the increase of weight drawn by an engine with a given expenditure of fuel; but there are many practical difficulties to be surmounted before the weight so drawn can reach the point when it could be destructive of roads. There are no theoretical reasons against the extension of the size of the engines. The difficulties, according to Mr. Gurney, are of a practical nature, and only in the 'difficulty of management of a large engine.' In proportion as we augment the power of the engines, we must increase their strength, and consequently their weight; the greater weight will be a material diminution of their efficiency. To a certain extent the power may be increased in a greater ratio than the weight, but with our limited knowledge of the application of steam, and with the present formation of the public roads, the point will be very soon attained, when the advantage of increased power will be counterbalanced by the difficulties attendant on the increased weight of the engines.

"The weight of the steam carriages at present in use, varies from 53 to 80 cwt.; but it must be recollected that they are mere models; they were made with attention to strength only, to bear the uncertain strain to which they would be exposed in the course of experiments, and a very considerable diminution of weight may be anticipated.

"The weight drawn, at the rate of ten miles per hour, by Mr. Gurney's engine, has not, on any extent of road, exceeded the weight of the drawing carriage; nor is it likely, with the difficulties to be encountered on the present lines of road, from their quality and the numerous ascents, that the weight drawn will be in excess of the strength of the roads. The immense quantity of spare power required to surmount the different degrees of resistance likely to occur, would render the engine too unmanageable. This will appear evident from the force of traction required to draw a wagon over the Holyhead and Shrewsbury road, which varied from 40 to upwards of 300 lbs.

"In considering the effect on roads, we must not overlook one peculiarity in which they have a great advantage over other carriages. In coaches drawn by horses, the power being without the machine to be removed, it becomes an object of the greatest importance to give as much effect as possible to the power, by diminishing the resistance arising from the friction of the wheels upon the surface of the road. For this purpose, the proprietors of coaches and wagons have adopted every possible contrivance, so to reduce the tires of their wheels, that a very small portion of them may press on the road; in some coaches they are made circular in their cross section, so that the entire weight of the carriage presses on a mere point; should the materials be soft, such wheels cut their way into the road like a sharp instrument. The owners of wagons too have adopted a similar plan. Mr. Macneil states that the actual bearing part of the tire of apparently broad wheeled wagons, is reduced to three inches by the contrivance of one band of the tire projecting beyond the others.

"With steam, on the contrary, a certain amount of adhesion to the roads is required to give effect to the action of the machinery, or the wheels would slip round and make no progress. It appears of little importance, therefore, so far as relates to the engine, whether the requisite amount of friction be spread over a broad surface of tire, or be concentrated to a small point; but as the wheels, by being too narrow, would have a tendency to bury themselves in every soft or newly made road, and thus raise a perpetual resistance to their own progress, it actually becomes an advantage to adopt that form which is least injurious to the road. The proprietors, who have been examined on this point, seem to be quite indifferent as to the breadth of tire they may be required to use.

"These considerations have convinced the committee, that the tolls enforced on steam carriages have, in general, far exceeded the rate which their injuriousness to roads, in comparison with other carriages, would warrant; they have

found, however, considerable difficulty in framing a scale of tolls applicable to all roads, in lieu of those authorized by several local acts.

"With this view they have carefully examined the various modes of imposing toll, either suggested by the witnesses or already adopted.

"They are as follows:

"1. To place a toll proportioned to the weight of the carriage and load.

"2. On the number of passengers.

"3. On the horse power of the engine.

"4. On the number of wheels.

"5. An unvarying toll.

"Each of these plans seems liable to serious objections, which the committee beg to submit to the house.

"No plan of toll has been more frequently recommended than that of a charge in proportion to the weight of the engine and load. As this is the most plausible, and (if it could be levied without other disadvantages,) would probably be the fairest standard, the committee have considered it right to state, at some length, their reasons for not recommending its adoption.

"If weight be taken as the standard, the toll must be a fixed charge, either upon the weight of the engine and carriage, without reference to the load; or upon an estimated average of the load carried; or a fluctuating charge, according to the weight, at the several periods of a journey.

"The first would be at least free from the uncertainty of the other two, and therefore would be preferable; but what scale of charge per cwt. could the committee recommend as applicable to all roads? Their toll should vary according to every different rate of charge on carriages; besides, it would appear to the trustees very unjust to exclude the consideration of that which would be deemed the most material cause of the wear of their roads; viz. the load.

"A fluctuating charge on weight would be most injurious to a carriage which will mainly depend for success on its speed; constant altercations would take place between the toll collectors and proprietors; a minute calculation would be required at every turnpike gate; in fact, unless an accountant were placed at each, the committee cannot conceive how the proportions could be satisfactorily arranged, nor would there be any desire, on the part of the toll collector, to shorten the delay occasioned by these interruptions.

"Mr. Gurney has delivered in a scale of tolls graduated according to weight and width of tire of the wheel. As this has been drawn up by a person interested in the success of steam carriages, it might have been expected to be more favourable to them. The committee, however, have not adopted it, because of the difficulties and interruptions which a fluctuating rate of toll would induce; besides, this scale purports to be intended for a road where 3d. is charged for a horse drawing, and 1d. for a horse not drawing; the scale would be inapplicable therefore when the charge was 2d. and 1d., 3d. and 1½d., 4d. and 1d., 4d. and 1½d., 8d. and so on. Again, what standard of weight, in relation to horse coaches, could be adopted? The average weight of loaded coaches differs very much on different roads. It has been suggested, that a loaded coach, including the weight of four horses, would weigh on an average four tons; and that if 6d. per horse were chargeable to the coach, 6d. per ton should be placed on a steam carriage; this would be unjust, as vans, which frequently weigh upwards of six tons, would only pay 2s., and a steam carriage would pay 3s. Even if the injury done to the road by each were equal, this would be an unfair toll; but it will appear more evidently unjust if the greater proportionate injury done by the feet of horses drawing, than by the propelling wheels, be taken into consideration.

"The object of every steam coach proprietor will be to attain the greatest possible lightness of machinery and engine; because thereby he renders his power more efficient for the draught of the remunerating load. To place the toll on the weight of the engine would tend to induce him to decrease the

strength of his boiler and machinery to an extent which might be dangerous to the passengers, and very detrimental to the success of steam travelling, as the public will easily be led to believe that the accidents really occurring from injudicious legislation, were inseparable from the adoption of this power as an agent in propelling carriages.

"The only fair plea for charging tolls on such carriages in proportion to their weight, is to prevent a load being propelled or carried which would permanently injure the road; within this limit it would be as injudicious to interfere with their progressive efficiency, (which can only result from improvements of the machinery and the system of generating and applying steam,) as it would be to tax carriages drawn by large and well-bred horses, more heavily than such as were drawn by horses in worse condition, and of smaller size and power.

"The roads at present have to sustain wagons, weighing, at times, with their horses, nearly ten tons; it is in evidence, that the breadth of wheels required by various acts of Parliament, is so easily evaded, that it affords no protection to the road. There appears to the committee no fair reason to suppose that steam carriages, approaching even to this weight, will be used on any turnpike road, at least for a very considerable period, during which the increase of weight will be gradual, and will give warning to the legislature when it should interfere.

"To charge a toll according to the number of passengers conveyed, is scarcely less objectionable. If a fluctuating toll be intended, it would be as inadmissible as to propose a similar mode of charging for fast coaches, and would be open to all the cavil and interruptions to which a fluctuating toll on weight would be liable. If the toll were fixed according to the number of passengers the carriage were capable of conveying, it would imply the necessity of a license limiting the number of passengers, and cramping the progress of improvement of a machine, the capabilities of which can only be ascertained slowly and by continued experiment.

"It must be also recollected that these carriages will probably have to travel for a long period without passengers, until by their punctuality and safety they shall have induced the public to venture in them. Nor is this probability weakened by the immense number of passengers who commenced using the locomotive carriages on the Manchester and Liverpool rail-way immediately after their introduction: these engines were established among a population accustomed to machinery and steam, and therefore not entertaining the same apprehensions of its danger which will require to be surmounted elsewhere.

"The trustees of the Liverpool and Prescot road have already obtained the sanction of the legislature to charge the monstrous toll of 1s. 6d. per 'horse-power,' as if it were a national object to prevent the possibility of such engines being used. Besides, they have supplied no standard of their own conception of horse power. Engineers have differed very much in their estimates of this power; there is not, therefore, much probability that the opposite interests of a steam coach proprietor and toll collector would lead to any agreement as to the meaning of the term. But suppose the legislature were to settle this point, and to arrange that a certain length of stroke and diameter of cylinder should represent a certain power, we still fail to ascertain that which alone it is essential to know, viz. the actual efficiency of the engine. Can we regulate the density of steam at which an engine of a given size should be worked? To be effectual, it would be also necessary to ascertain the quantity of water consumed, and even this check would be inadequate with an engine on Mr. Trevithick's principle. If the toll be left as at present on 'horse power,' it would be the obvious interest of the proprietor to work with the smallest nominal power, but to increase as much as possible the force of his steam, thereby increasing the probability of explosion.

"Some trustees have placed the toll upon the number of wheels. The committee would object to this mode of charge, if only because it interferes between

the rival modes of steam travelling, and gives a bounty in favour of that in which the engine is placed on the same carriage with the passengers. The opposite plan of separating the engine from the carriage is that which probably the public will prefer, until the safety of the mode of conveyance shall have been fully ascertained.

"There is still a more serious objection to this mode of charge: it tends to discourage the use of separate carriages; although it must be evident that if a certain weight be carried it will be much less injurious to the road when divided over eight wheels, than when carried on only four. On this point the committee must again refer to Mr. Macneil's evidence. They cannot, therefore, recommend the house to adopt a scale of toll which shall increase in inverse proportion to the injury done to the road. It will be seen in Mr. M'Adam's evidence, that the toll on steam coaches imposed by the metropolitan roads act, is liable to this objection.

"Some of the local acts have placed an unvarying toll on steam carriages. This, if moderate, would be unobjectionable; but the committee could not propose any sum which would adapt itself to the necessary varieties of expense in keeping up different roads, by which the tolls on common carriages have been regulated. A fixed toll has, too, this disadvantage: that light experimental carriages, or such as are built solely for speed, would be liable to the same toll as steam carriages heavily laden.

"The committee feel that, however strong their conviction may be of the comparatively small injury which properly constructed steam carriages will do to the roads, yet this conviction is founded more on theory, and perhaps what may be considered as interested evidence, than practical experience; they would therefore recommend that the house should not make, at present, any permanent regulations in favour of steam. The experience which will be gained in a very few years, will enable the legislature to form a more correct judgment of the effect of steam carriages on roads than can be now made. They therefore recommend that the *tolls* imposed on steam carriages by local acts, where they shall be unfavourable to steam, shall be suspended during *three years;* and that, in lieu thereof, the trustees shall be permitted to charge toll according to the rate to which the committee have agreed.

"The house will have perceived, in the former part of this report, that there are two modes of applying steam in lieu of horses in draught: one, where the engine and passengers are on the same carriage; the other where the engine is placed on separate wheels, and is merely used to propel or draw the carriage. Although the difference of weight may be in favour of the former mode, yet, as on the latter it is divided over eight wheels instead of four, its small excess cannot justify a larger toll being imposed, as it will be found much less injurious to the roads. The committee therefore recommend that, in charging toll, the engine carriage and carriage drawn shall be considered but as one.

"As it is the opinion of all the engineers examined, that the use of narrow wheels has been the great cause of the wear of roads, and that cylindrical wheels of certain width of tire, are not only the least injurious, but that, in some states of the road, they may be even beneficial, the committee recommend that the wheels of the engine carriage should be required to be cylindrical, and of not less than three and a half inches width of tire. No proprietor of steam carriages has expressed the slightest fear of any inconvenience or loss from the use of such wheels. Beyond this, the committee would not recommend interference with the breadth of tire, or form of wheels: it should be left to the proprietors freely to select the breadth of tire they shall find most convenient in proportion to the weight carried.

"The committee have divided steam carriages (intended for passengers) into two classes, to be subject to different rates of toll. The first, where the carriage is not plying for hire, or where, if plying for hire, it shall not be calculated for, or carry at any time, more than six passengers. The original cost of such machines, and the expense of working them, will sufficiently protect the

roads from any great number of merely experimental carriages; and for the same reason they will not be of a weight or size likely to be injurious. A steam carriage only calculated to convey six passengers, will be solely used where great speed is required, and will be so light as to cause very little wear of the road, probably much less than many carriages drawn by the number of horses which the committee recommend as the standard of charge for this class. The toll, therefore, proposed to be placed on this class of steam carriages, is that which (on the several roads where they may be used) is charged on a carriage drawn by two horses.

"In the second class, they have placed all other steam carriages, except those travelling at slow rates, for goods only: carriages of this class should pay the same toll as may be charged on a coach drawn by four horses. This may at first appear unjust from the supposed power of steam to draw almost unlimited weight. The committee have already enumerated the difficulties hitherto encountered in attempting to propel very heavy loads on turnpike roads. They are such as to discourage the expectation that, within any short period of time, the system will have been so perfected as to give rise to inconvenience from this source; should any hereafter be found it will then be sufficient to remedy the defect. Until a due proportion of the parts of the machinery shall have been ascertained, the makers of these carriages will vary but cautiously from the models at present in use: their object will be, for some time, the perfecting of them, rather than the uncertain experiment of increasing their size.

"The committee do not anticipate that, for a considerable period, steam will be used as a propelling power on common roads for heavy wagons. It appears to have been the general opinion of the witnesses, that, in proportion as the velocity of travelling by steam on common roads is diminished, the advantages of steam over horse power are lost. The efficiency of horses in draught is rapidly diminished as their speed is increased; while, on the contrary, the weight which could be carried or propelled at any great velocity by steam, could not be more cheaply conveyed were the speed decreased to that of the slowest wagon.

"As speed, therefore, is the cause of greatly increased expense where horses are used, while with steam it is comparatively unimportant, it is probable that the latter will be chiefly resorted to when rapidity of conveyance is required. Mr. Gurney considers, that, under four miles per hour, horses can be used in draught more economically than steam. Should it, however, be deemed profitable to convey heavy goods by steam carriages, the committee recommend that there should be as little interference as possible with the number of carts employed; as the effect on the surface of roads would be infinitely more injurious if heavy loads were placed on a single cart, than if the same weight were divided over several. The committee recommend, that where carriages, containing heavy goods alone, are propelled by steam, the weight of the load should be charged, without reference to the number of carts on which it may be carried.

"As a horse is able to draw from twenty to forty cwt. on common roads, they propose that each twenty cwt. of load, conveyed in, or drawn by a steam carriage, should be chargeable at the same rate of toll as one horse drawing a cart.

"A charge on weight is not so objectionable where goods are conveyed at a slow rate, as when speed is alone required.

"In conclusion, the committee submit the following summary of the evidence given by the several witnesses, as to the progress made in the application of steam to the purposes of draught on common roads.

"Sufficient evidence has been adduced to convince your committee—

"1. That carriages can be propelled by steam on common roads at an average rate of ten miles per hour.

"2. That at this rate they have conveyed upwards of fourteen passengers.

"3. That their weight, including engine, fuel, water and attendants, may be under three tons.

"4. That they can ascend and descend hills of considerable inclination with facility and safety.

"5. That they are perfectly safe for passengers.

"6. That they are not (or need not be, if properly constructed) nuisances to the public.

"7. That they will become a speedier and cheaper mode of conveyance than carriages drawn by horses.

"8. That as they admit of greater breadth of tire than other carriages, and as the roads are not acted on so injuriously as by the feet of horses in common draught, such carriages will cause less wear of roads than coaches drawn by horses.

"9. That rates of toll have been imposed on steam carriages, which would prohibit their being used on several lines of road, were such charges permitted to remain unaltered."

The following bill, introduced in accordance with the views expressed in the foregoing report is extracted from the Mechanics' Magazine for March last.

*Bill to regulate the Turnpike Toll on Steam Carriages.*

"Whereas, of late years there has been invented an application of the power derived from steam to the propelling of carriages along the roads of this kingdom, and such invention is likely to become very beneficial to the public: And whereas in the absence of a just knowledge of the effect produced upon roads by carriages so propelled, and under a notion that such carriages would be more detrimental to the roads, and occasion greater inconvenience to travellers, than other carriages drawn by horses, various local acts of Parliament have been passed, imposing excessive tolls upon carriages propelled by steam or other elemental or mechanical power, amounting in some instances to a prohibition of the use of the said invention: And whereas the greater number of all the other acts of parliament whereunder tolls upon the roads and bridges of the united kingdom are collected, were passed before the said discovery was made, and by such acts no toll is imposed on any carriage so propelled as aforesaid; nor until such several acts shall be amended, or a provision in regard to the said insufficiency of such acts shall otherwise be made by parliament, can any tolls whatsoever upon carriages so propelled along the several roads or over the bridges to which such acts respectively relate be lawfully demanded; whereby in such instances the proprietors of carriages so propelled avoid contributing their fair proportion of the expense of maintaining the said roads and bridges: And whereas the public ought not to be so precluded from benefitting by the said invention, and all such legislative obstructions to the further improvement of this application of steam, and to a free and extensive adoption of it, should for a limited time be suspended; and also, throughout the realm a reasonable toll should be paid in respect of every carriage so propelled along the said roads or over the said bridges;—be it therefore enacted, by the king's most excellent majesty, by and with the advice and consent of the lords, spiritual and temporal, and commons, in this present parliament assembled, and by the authority of the same, That throughout the united kingdom of Great Britain and Ireland, from and after the *first day of July next following the passing of this act*, all and every toll and tolls imposed by any turnpike or other act of parliament whatsoever upon any carriage propelled by any means or power other than animal power, by whatsoever name or description such carriage shall be called or known, shall cease during the continuance of this act, and not be collected.

"And be it further enacted, that from and after the day aforesaid, the tolls mentioned and set forth in the schedule to this act annexed, and no other tolls whatsoever shall be collected or taken on any carriage, by what name or description whatsoever the same shall be called or known, which shall be pro-

pelled by means of steam or other elemental or mechanical power, or by any power other than animal power, along any road or over any bridge whatsoever, in any part of the united kingdom. Provided always, that nothing in this act shall authorize any such toll to be collected in respect of any carriage so propelled along any such road or over any such bridge, unless and during such time only, and at such place or places only, as tolls upon carriages drawn by horses, whether such carriages drawn by horses shall be coaches, stage-coaches, chaises, post chaises, wagons, carts, or carriages of other names or descriptions, along such road or over such bridge, shall by law be receivable.

"And be it further enacted, that where the tolls on carriages drawn by horses shall expire, or otherwise be no longer receivable, there also the aforesaid tolls on propelled carriages shall likewise cease, and be no longer receivable.

"And be it enacted, that no toll shall be collected upon any propelled carriage, which carriage shall belong to or be in the employment of his majesty or any of the royal family, or being employed in conveying the mails or king's stores, or officers or men in the army, including yeomanry and volunteers, or the navy on service, or in carrying agricultural produce to or from market or sale, or in taking persons to or from church, or a funeral, or a county election, or on carrying the surveyor of the road, or in the transmission of vagrants.

"And be it further enacted, that if after the commencement of this act, any toll-taker or other person shall take or shall demand any toll upon any carriage so propelled, other than the toll imposed by this act, he shall for every toll so taken or so demanded forfeit and pay the sum of *five pounds*, one half thereof to our lord the king, and the other half to him that will sue for the same, to be recovered in an action of debt in any court of record in the united kingdom, with full costs of suit. Provided always, that such action shall be commenced within *ninety* days after the day of taking such toll.

And be it further enacted, that this act shall commence from *twelve* of the clock at noon of the *first day of July* next, and shall continue in force from that day during *five years*, and to the end of the then next session of parliament."

*Schedule of Tolls payable on Steam Carriages, or Carriages propelled by any means other than Animal Power.*

"Where any such carriage is not plying for hire, or if plying for hire shall carry not more than *six* passengers, the like toll as shall be payable in respect of a four-wheeled coach drawn by two horses; and if carrying a greater number of passengers than *six*, the like toll as shall be payable in respect of a four-wheeled coach drawn by four horses.

"And when the tire of the wheels of such carriage shall be less than three inches and a half in width, or have a greater degree of convexity than half an inch; the toll to be taken on such carriage shall be *double* the aforesaid tolls respectively.

"Where any such propelled carriage shall be used in the place of a wagon or cart for conveying goods or other things, and the load shall not exceed *one ton of twenty hundred weight*, the like toll as shall be payable for a single horse drawing a cart; and for every further ton or fraction of a ton, a further toll of the like amount.

"And where the engine carriage shall be a separate carriage from the first train-carriage conveying passengers or goods, the engine carriage shall not be charged separately, but one toll only shall be taken for both carriages.

"And where the engine carriage shall draw more than one train carriage, then for every train carriage after the first train carriage, a further toll of *one half* of the single toll shall be taken, and no more."

[TO BE CONTINUED.]

## TRANSLATIONS FROM FOREIGN JOURNALS.

[Translated for this Journal.*]

### *On the Bleaching Powers of Alkaline Chlorides.*

Welter found that the liquid resulting from the absorption of a certain bulk of chlorine, by an alkaline solution, possessed the same bleaching power as the chlorine itself. This is true of the bleaching effects, as shown by a solution of sulphate of indigo; the chlorine being disengaged from the solution which has absorbed it. The same is not true of the bleaching effects upon solutions which are not acid. I made a solution of a known volume of chlorine in water, and of the same volume in a weak solution of carbonate of soda. The bleaching effects of these two solutions appeared to be the same by the test of sulphate of indigo. With colouring matter containing no acid, the alkaline solution always proved the less powerful. The bleaching power of the solution of any chloride, is much increased by adding an acid, which confirms the above remarks.

By using a solution of ink, which was not acid, I found the relative bleaching powers of chlorine and of chloride of soda, to be as 1.62 to 1. The colouring matter from the petals of the red poppy, gave a ratio of 1.66 to 1.

It should be observed that when a chloride has produced its appropriate effects, the action of an acid cannot increase them.

I will not leave this subject without observing first, that the bleaching power of a chloride as usually determined, is not that of the chloride itself, but of the chlorine used in producing it. Second, that the presence of an acid augments the bleaching powers of a chloride. These remarks may serve to explain certain facts observed in the bleaching, &c. of printed stuffs. (Soubeiran, Recherches sur quelques combinaisons de chlore.)

[*Ann. de Chim. et Phys. Oct.*, 1831.

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### Royal Ordinances of France relating to Steam-Boats.

(Continued from p. 110.)

#### *I. Of the Superintendence and Management of the Engine.*

1. The *permit* of navigation is to be granted only on the express condition that on board of every boat, intended for the reception of passengers, there shall be a person whose constant business it shall be to superintend the engine, and who must have sufficient skill to keep it always in order, to know when it works well in all its parts, and, if needed, to repair it.

2. The duties of this engineer cannot be entrusted to the fireman, who is to be under the direction of the engineer.

3. The engineer must observe all the ordinary measures of precaution prescribed by the ministerial instructions of 19th March,

* By request of the Committee on Publications.

1824; and to this end, these instructions ought to be hung up near the engine.

### *II. Of the Supply of Water within the Boiler.*

4. To enable the engineer to determine that the supply of water to the boiler is sufficient to compensate for the water used in producing steam, for working the engine or to supply waste, and that thus the surface of the water in the boiler is kept at a constant level above the flues within; two gauge tubes of glass must be adapted (besides the ordinary floats) to the boiler, and must be constantly kept in a sound condition. In the adjustment of these tubes, regard must be had to the effects of dilatation by heat.

Each of these tubes is to be fitted vertically between two horizontal copper tubes, which are provided with stop cocks, and which communicate with the interior of the boiler, one above and the other below the water line, so that the water will stand at the same height in the glass tubes as in the boiler.

Several of these tubes must be kept at hand, so that if those on the boiler should be broken, they may, immediately, be replaced.

The same purpose may be answered by three gauge cocks, which must be placed thus: the first, at the ordinary level of the water, the second a little above, and the third a little below the same. But the use of glass tubes is to be preferred in river navigation.

5. A safety tube, terminated by an organ pipe, should be adjusted to the boiler, and so disposed that if, from any unforeseen cause, the surface of the water in the boiler should fall below the proper level, the steam escaping through this pipe would produce a noise, giving notice of the danger and the necessity of instantly remedying it.*

### *III. Of the Safety Valves.*

6. The engineer ought to be careful that the safety valves are in good order.

7. The safety valves of high pressure engines must be loaded by means of a lever, those of low pressure engines directly.

Overloading the safety valves is expressly prohibited.

8. The weight on the safety valve is to be determined in pounds and fractions of a pound according to the number of the stamp of the boiler.

If the boiler be a low pressure one, and terminated with plane ends, (in which case, not having been proved, it cannot be stamped,) the safety valves must be loaded directly, with a weight equivalent at most to half an atmosphere, that is, with a weight of seven and a half pounds to every square inch.

### *IV. Of the Fusible Metallic Plates.*

9. It is expressly forbidden to use metallic plates not corresponding

* The reader will perceive that several of these regulations could not be applied, in practice, to the boilers of high pressure engines, working at the pressure used in this country.—Trans.

in their fusing point to the number on the stamp of the boiler, or to endeavour, by any means whatever, to prevent the fusion of the plates.

10. Covers are ordered to be placed over the plates (not, however, to be fastened down) which will preserve them from injury, and prevent the access of water or any foreign substance; at the same time, inspection must be easy, that the number of their stamp may be made out at first sight.

11. A number of metallic plates must be kept constantly on hand in every boat, so that those which may melt may be instantly replaced.

### *V. Of the Steam Gauges.*

12. A mercurial gauge must be adapted to every boiler. It must be constructed with care, and graduated with exactness.

13. An open gauge must always be used for low pressure boilers, and as far as possible for high pressure boilers also. This gauge is much to be preferred to the short gauge closed at top and containing a column of air.

14. The necessary precautions should be used to preserve this instrument from injury; but there must always be at hand a gauge, beside the one on the boiler, to take the place of the latter in case of accident.

### *VI. Of the management of the Fire and of the Engine.*

15. The engineer must see that the fireman manages the fire with the greatest regularity, and observes all the precautions pointed out in the ministerial instructions of 19th March, 1824, which must, for this purpose, be hung up somewhere near the engine, as has been already directed.

16. When the boat approaches a stopping place, the captain must give notice of the fact to the engineer and the fireman, that the latter may cease to urge the fire.

If, when the boat is not in motion, the column of mercury in the steam gauge should continue to rise, the engineer must let off the steam.

17. If the level of the water within the boiler should be depressed too much, and the boiler become red hot in parts, the engine must be stopped to introduce water into the boiler, and the steam should be allowed to escape only through the safety valve, or through a discharge cock.

In such a case it will be necessary to put out the fire, and allow the boiler to cool down, before water is introduced.

### *VII. Of the Internal Police of Steam-boats.*

18. Captains are expressly forbidden to run their boats at a speed greater than that given by the regular working pressure of the engine, under penalty of being personally responsible for any accident which may occur in consequence of such conduct.

19. There shall be kept open, in every steam-boat, a register, the contents of which shall be examined by the local authorities and transferred to their notes. Upon this register the passengers shall have an opportunity to note their observations in relation to the going of the boat, and to accidents, if any, which may have occurred.

20. These registers shall be submitted for inspection to the committees of superintendence, whenever they visit the boat; and to the authorities charged with local arrangements in the communes situated along the water course, whenever these authorities wish to see them.

21. In every house for the reception of passengers, there should be hung up a notice, on which should be stated:

1st. The mean duration of the passage, both in going up and coming down, allowance being made for the current.

2nd. The time that the boat is to remain at the landing places.

3d. The greatest number of passengers the boat may carry.

4th. The right which passengers have to note their observations on the register opened for that purpose in the boat.

22. Captains are bound, after each trip, to declare to the local authorities all the facts which come to their knowledge, likely to be of interest to the safety of the navigation, so that measures may be taken, if necessary, in relation to them.

23. Lastly, the local regulations should specify the working pressure of every engine, the number of the stamp on the boiler, the proper load for the safety valves, the melting points of the fusible plates used, and the height of the mercury in the gauge, corresponding to the ordinary working pressure.

Said regulations must also embrace all the measures of local interest which the Prefects think proper to prescribe for the regulation of steam navigation; they must also contain an enumeration of the cases in which the *permit* of navigation may on account of violation of the regulations, be withdrawn, for a longer or shorter time. They should mention, also, that according to articles 319 and 320, of the penal code, the proprietors of boats are liable to criminal prosecution for accidents which may have arisen from their negligence, imprudence, or want of attention to the regulations, and that too without prejudice to the damages which they may have incurred.

The observance of the regulations imposed on the proprietors of steam-boats should be carefully attended to, not only by the committees of superintendence, but also by the engineers of mines, government civil engineers, officers of the ports, mayors, and adjuncts, commissaries of police and officers and sub-officers of gendarmerie, in the cities and communes situated on the lines of navigation.

It is the duty of officers in their several stations to report to the Prefects all infractions of regulations, and all accidents.

On the receipt of such reports, the Prefect having first examined into the charges contained in them, shall take such measures as he thinks proper to bring the offenders to justice.

If it happen that an infraction occurs in a different department from that in which the *permit* of navigation was granted, the Prefect

of the former department shall transmit the charges to his colleague in the department where the permit was granted, to be acted upon by the latter.

It is of importance that the visits of the committee of superintendence be made very frequently, and not only when the boats are *at the wharf*, but also when they are on the passage. The report of each visit should state the nature of the inspection made and its results.

Observations should be made especially in relation to the load and play of the safety valves, the play of the float, the condition of the fusible plates, of the stamps, and of the gauges, the condition of the gauge cocks, or of the tubes for showing the level of the water, the state of the flues and of the furnace; also in relation to the degree of regularity with which the heat is applied, and the feeding of the boiler kept up; in relation to the due strength of the boiler and boiler tubes, and their state with respect to interior cleanliness, &c., to the leakage of the boiler; its influence on the working of the engine, to the regularity of the play of the engine, to the more or less favourable location of the boiler in reference to the boat, and to the degree of exactness with which the local regulations imposed by the permit of navigation are executed.

When the committee of superintendence have reason to suppose that any low pressure boiler with plane ends is not of sufficient strength, they should require the proper alteration to be made in presence of the Prefect.

If the suspected boiler be of such a form that it can be proved by the hydraulic press, the committee must order a proof by that machine, and be present during the trial. The pressure employed for this proof must be equal to that to which the boiler was subjected at the time of its being stamped.

In this case, as in that of the original trial, the proprietor of the boat is bound to furnish the press and the manual assistance required. There is no objection to the proprietor of the boat furnishing, instead of the ordinary trial press, a forcing pump, such as the feeding pump of his engine, provided it be easy to use, and sufficiently powerful. It is hardly necessary to add that the proof ought to be repeated every time that it is judged necessary for the perfect security of the boat.

Finally, besides their opinion upon the proper measures in relation to boilers which they suspect to be wanting in strength, the committees of superintendence should add to the report of each visit every suggestion which the exigency of the case, or the good of the service, may seem to call for. They should never lose sight of the fact that it is their duty to originate as well as to execute.

(Signed,) Baron Capelle,
*Minister of Public Works.*

*Paris*, 27 *May*, 1830.

**New table of the elastic force of steam, and the corresponding temperatures; deduced from *experiment*, from one to twenty-four atmospheres, and *calculated* for the remainder.**

| Elastic force of steam, taking the pressure of the atmosphere as unity. | Height of the column of mercury at 32° Fah. corresponding to the elastic force of the steam. | Corresponding temperature expressed in degrees of Fahrenheit's thermometer. | Pressure exerted of the steam on a square inch of surface of the boiler or safety valve. |
|---|---|---|---|
| Atmospheres. | Inches. | Degrees. | Pounds. |
| 1 | 30 | 212.0 | 15 |
| 1½ | 45 | 234.0 | 22.5 |
| 2 | 60 | 250.5 | 30 |
| 2½ | 75 | 263.8 | 37.5 |
| 3 | 90 | 275.2 | 45 |
| 3½ | 105 | 285.1 | 52.5 |
| 4 | 120 | 293.7 | 60 |
| 4½ | 135 | 300.3 | 67.5 |
| 5 | 150 | 307.5 | 75 |
| 5½ | 165 | 314.2 | 82.5 |
| 6 | 180 | 320.4 | 90 |
| 6½ | 195 | 326.3 | 97.5 |
| 7 | 210 | 331.7 | 105 |
| 7½ | 225 | 336.9 | 112.5 |
| 8 | 240 | 341.8 | 120 |
| 9 | 270 | 350.8 | 135 |
| 10 | 300 | 358.9 | 150 |
| 11 | 330 | 366.9 | 165 |
| 12 | 360 | 374.0 | 180 |
| 13 | 390 | 380.7 | 195 |
| 14 | 420 | 386.9 | 210 |
| 15 | 450 | 392.9 | 225 |
| 16 | 480 | 398.5 | 240 |
| 17 | 510 | 403.8 | 255 |
| 18 | 540 | 408.9 | 270 |
| 19 | 570 | 413.8 | 285 |
| 20 | 600 | 418.5 | 300 |
| 21 | 630 | 423.0 | 315 |
| 22 | 660 | 427.3 | 330 |
| 23 | 690 | 431.4 | 345 |
| 24 | 720 | 435.6 | 360 |
| 25 | 750 | 439.3 | 375 |
| 30 | 900 | 457.2 | 450 |
| 35 | 1050 | 472.7 | 525 |
| 40 | 1200 | 486.6 | 600 |
| 45 | 1350 | 499.1 | 675 |
| 50 | 1500 | 510.6 | 750 |

* The temperatures corresponding to 4½, 5, 8, 11, 19 and 45 atmospheres are given erroneously in the table which was copied into this journal (p. 137, vol. vi.) from an English periodical. Trans.

### *On Indelible Inks for Writing on Paper.*

The Committee having examined the different kinds of liquid indelible inks, are of opinion that they cannot safely be used; that the solid parts tend to separate from the liquids, and that thus time destroys the ink before use: to this defect purchasers must always be exposed. They are of opinion that solid inks offer great advantages. They consider India ink to rank first among them. The peculiar composition of this ink is not entirely known; but as imported it is a common and cheap article, so uniformly good in its quality, that, all circumstances considered, it cannot be made from a private receipt, but must be made according to one commonly known. This ink has one defect, that of not sinking into well sized paper; its good qualities are, indestructibility by age, and by chemical reagents.

The European imitation of India ink is made from lamp black, glue, and gum. Although inferior to the genuine ink, its characters are similar to those of the imported article. The ink used by the ancients was of this sort. These inks penetrate paper less readily than the India ink.

The Committee offer the following receipts for indelible writing inks:

*First Receipt.*—Dilute muriatic acid until it has the specific gravity of 1.01 ($1\frac{1}{2}$° Baumé.) Use this liquid instead of water in mixing India ink.

The ink runs more readily when diluted acid is used than when water alone is employed. It is flowing, and penetrates the paper.

*Second Receipt.*—To a solution of acetate of manganese of the specific gravity of 1.07 (10° Baumé,) add one ninth of its bulk of acetic acid (vinegar,) of such a strength that 100 parts will saturate 160 parts of crystallized carbonate of soda. Use this liquid to rub India ink. To render this ink indelible, expose the writing to the action of ammoniacal gas, by holding it over a solution of ammonia. This ink has the advantage over the first of not exposing the paper to acid reaction, the method of using it is, however, not so simple. [Report of a Committee* of the Academy of Sciences of Paris.]

[*Ann. de Chim. and Phys. Sept.*, 1831.

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### *On the use of particular kinds of Paper, for preventing the removal of Writing, &c.*

Colouring matters which, placed upon paper, would prevent the removal of ink, must be changed by all reagents which would destroy common ink. Such matters are usually destroyed by air and light, and may be affected by substances accidentally brought in contact with them.

* Gay Lussac, Dulong, Chaptal, Deyeux, Thenard, D'Arcet, Chevreul, and Serullas.

Notwithstanding such objections, paper of this kind may be useful. For example, the paper proposed by M. Contin, may be of great use in ordinary business transactions, particularly that covered with delicate and regular designs; even the tinted paper proposed for larger documents may be used with advantage.

We should in all cases prefer the use of an indelible ink.

[*Ibid.*

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### *Sulphate of Copper in Bread.*

In examining the subject of the use of sulphate of copper in preparing bread, M. Sarzeau has endeavoured to ascertain some method by which the copper always found in grain, may be distinguished from that in the sulphate of copper, which may be used in preparing bread, and also what proportion of the latter salt renders bread *poisonous*. The results of his experiments, those relating to the noxious qualities having been made upon himself, are as follow:

1. Whenever the ashes of bread give copper by the action of the blow-pipe, copper has been used in making the bread.

2. When the liquid resulting from mixture of the ashes of the bread with water, gives a red shade to the ferrocyanate of potassa, the bread has noxious qualities.

3. If the sulphate of copper used is $\frac{1}{5625}$th part, by weight, of the flour used in making the bread, the poisonous qualities will be decidedly felt. [*Journal de Pharmacie for April*, 1832.

B.

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### *Original experiments on the Adhesion of Valves, or Disks, operated on by Diverging Streams of Compressed Air. By* Mr. T. Hopkins.

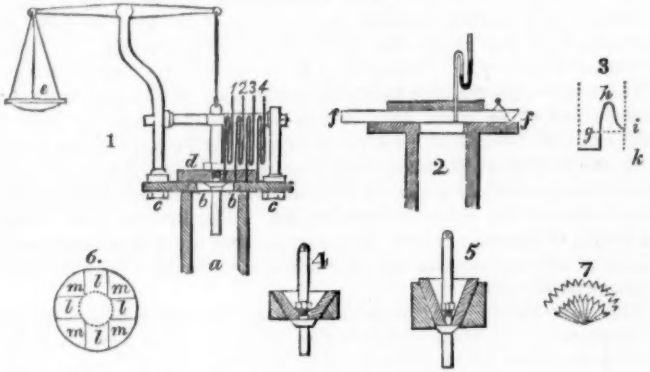
From the Transactions of the Literary and Philosophical Society of Manchester.

On the 11th of October, 1824, Mr. Roberts affixed a valve to the aperture of a pipe, used as a waste pipe, for the purpose of regulating or equalizing the force of a blast of air which was blowing a furnace. To his surprise, however, he found that the valve, instead of being readily blown off by a strong blast, remained at a small distance from the aperture of the pipe, and was removed to a greater distance only by a considerable exertion of the power of the hand. This singular phenomenon was witnessed by many gentlemen, members of this society, in the same week, and appeared to be viewed by them all as equally new and extraordinary.*

* It is said that Mons. Clement, of Paris, was in Manchester at this period, and that he saw the air valve adhere to the pipe, yet he afterwards, it appears, represented the discovery to have been made in France long subsequent to the time at which he saw it at Mr. Roberts' works.

Mr. Roberts made some experiments on his air valve at the time, and various theories were then suggested to account for the adherence of the valve to the pipe. It was not, however, until the month of September in the present year, that I agreed to join him in making further experiments, a part of which I now proceed to give.

A vertical section of part of the apparatus used is given in fig. 1, where *a* is a pipe, three inches diameter, with the aperture contracted to $2\frac{3}{8}$ diameter, at *b*, *b*, and surrounded by a flanch *c*, *c*, $10\frac{3}{4}$ diameter, to form a seat for a valve. On this seat was placed a circular disk or valve *d*, six inches diameter, with a pin in its centre, by means of which it was left at liberty to rise or fall freely, and kept at the same time perpendicular to the aperture.




The valve was attached to one end of a scale beam by a string, and balanced by weights placed in a scale *e*, attached to the opposite end of the beam. The valve being thus placed on the seat without any weight of its own to press downward, the stream of compressed air was admitted into the pipe *a*, when the valve *d* rose from the flange or seat *c*, 1-32nd of an inch, and there remained stationary. Thirteen ounces, avoirdupois weight, were now put into the scale *e*, which raised the valve to 1-12th of an inch above the seat. Twenty-six ounces raised it to 1-8th of an inch, and thirty-two ounces raised it to 1-4th of an inch, but any weight beyond this last caused the valve to fly abruptly off.

It thus appeared, that when the valve was raised from its seat a quarter of an inch, there was the greatest difference between the force of the issuing current of air pressing against the *under* side of the valve, and of atmospheric pressure on the *upper* side of the valve. The pressure of the atmosphere was greater than the force of the issuing stream of previously compressed air, a weight of thirty-two ounces being requisite to establish an equilibrium.

That we might ascertain what was the state of the stream of air under the valve, in different parts of it, four double syphon tubes were procured, and proper quantities of mercury being put into them,

they were inserted in holes made through the valve at certain distances from each other, as shown in fig. 1 at 1, 2, 3, 4. The inserted limbs of these tubes being thus left exposed to the action of the stream of air, the compressed air was again admitted into the pipe *a*, and the valve rose as before, 1-32nd of an inch.

The tube 1, in that part of the valve *d*, which was over the aperture *b*, had the mercury in it 1½ inches higher in the *outer* than in the inner limb, and consequently showed a pressure from the compressed air below it, above atmospheric pressure, equal to 1½ inches of mercury. The tube 2, which was near to the aperture *b*, but over the inner edge of the seat *c*, showed a rise of the mercury of 3-10ths of an inch in the *inner* limb of the tube, and consequently a pressure from the air below it *less* than atmospheric pressure by 3-10th of an inch,—or a partial vacuum of 3-10ths of an inch of mercury. The tube 3, at the same time showed a similar vacuum of 1-8th of an inch of mercury. The mercury in the tube 4 was undisturbed.

The valve with the four tubes in it was now raised above its seat from 1-32nd of an inch, until it was 1½ inches above the seat, by gradations of 1-32nd of an inch each, and the heights of the mercury in the tube were noted at each step, distinguishing by a *p* or a *v*, whether they showed pressure from below, or a partial vacuum, and thus a table of five columns was formed. The first column showed the height of the valve above the seat, and the other four columns the heights of the mercury in the four tubes, and whether they indicated pressure or vacuum.

This table showed that the pressure from the stream below, on tube 1, continued at 1½ inches of mercury, until the valve was raised from its seat to 1-16th of an inch above it; but from that elevation until it was raised to 1½ inches from the seat, the mercury showed a gradually diminishing pressure, and at that height the pressure was only 6-10ths of an inch.

Tube 2 showed its greatest degree of *vacuum* which was one and 8-10ths inches of mercury, when the valve was raised 3-32nds of an inch; from which point, as the valve was further elevated, the vacuum became less, until at a height of 3-8ths there was no vacuum,—the mercury in the two limbs of the tube being at the same level. On raising the valve from 3-8ths to 1½ inches, this tube showed an increasing *pressure* from the stream of air below, and at the least named height the pressure was 4-10ths of an inch of mercury.

The tube 3, showed its greatest degree of vacuum to be 7-20ths of an inch of mercury, and it was when the valve was up 11-32nds of an inch. As the valve was raised higher, the vacuum became less, until at the height of 1½ inches it was nothing.

In tube 4, the mercury began to show a small degree of vacuum when the valve was raised 3-32nds of an inch; when it was up half an inch the vacuum was one-fourth of an inch, being its greatest degree; from this point the vacuum diminished, and when the valve was 1½ inches high, there was very little difference in the levels of the mercury in the two limbs.

A similar course of experiments was gone through with a valve

eight inches diameter, with some small variations in the results, which were noted in another table; but the only one worth mentioning is, that while the six inch valve required a little more than thirty-two ounces in the scale *e*, to detach it from its seat, the eight inch valve required forty-eight ounces.

From a general view of the results thus obtained, it appeared that while the valve adhered to the seat, and remained at but a small distance from it, a circular stripe or flat ring of attenuated air was found between the valve and its seat, and near to the aperture *b*, the air at the same time in the parts further from the aperture becoming more dense, until close to the periphery it became nearly of atmospheric density; but as the valve was raised, the ring of the attenuated air approached the outer part or periphery of the valve.

To find the form and nature of this ring, it now appeared desirable that the different heights of mercury in the same tube, indicating degrees of vacuum should be ascertained at small and equal distances, beginning at the edge of the aperture, and proceeding along a radial line to the periphery of the valve. To accomplish this, a moveable slide was dovetailed into the valve, and in this slide was inserted the lower limb of one of the double syphon tubes with mercury in it as before, shown at fig. 2, where the tube is placed over the aperture, and indicates a pressure from the compressed air of $1\frac{1}{2}$ inches of mercury.

This valve being placed on the seat, the slide *f*, *f*, was moved until the tube came over the seat, and the distance of the tube from the edge of the aperture was noted when the mercury first indicated a slight degree of vacuum. From this point the slide, and consequently the tube, was drawn outward 1-32nd of an inch, and the height of the mercury indicating vacuum again noted. In this way, by stages of 1-32nd of an inch each, the tube was drawn to the outer edge or periphery of the valve, and at the height of the mercury noted at each stage. The different heights of the mercury in all these stages, with the exact places of the tube at the times, were then marked by dots on paper, and these dots being connected by lines, we obtained the curve represented in fig. 3. In this diagram *g* shows the point at which the vacuum was first indicated, and the line from *g* to *h*, represents the increase of the degree of vacuum, until at *h*, it is $1\frac{3}{4}$ inches of mercury. From this point the reduction of the degree of vacuum is seen by the curve from *h* to *i*. The straight line *k*, a little lower down, represents the pressure which the mercury showed when the tube was over the aperture.

The valve was now raised higher from its seat, and the tube moved as before, and data obtained for the formation of other curves. When the valve was 3-16ths above the seat, the tube being placed over the aperture, showed a pressure of only one and four-tenths of an inch of mercury; but the tube being brought over the seat at a distance of 5-32nds from the edge of the aperture, showed a vacuum of one and eight-tenths of an inch of mercury. From that point proceeding outward, the vacuum became less.

These experiments showed, that until the valve was raised to a

certain height above its seat, the under side of that part of the valve which was over the aperture, was exposed to a pressure of $1\frac{1}{2}$ inches of mercury more than atmospheric pressure; and the under side of all the rest of the valve, forming an outer stripe or ring, was exposto a pressure less than atmospheric, or had a partial vacuum varying from one and eight-tenths of an inch of mercury up to atmospheric pressure. The superior pressure against the under side of the centre of the valve, must then have been counterbalanced by the inferior pressure against the under side of that portion of the valve which is nearer to the periphery,—and more than counterbalanced, for atmospheric pressure on the top of the valve was still so superior as to admit of a weight of thirty-two ounces being applied, before that pressure could be overcome and the valve raised.

Valves of various smaller sizes were now tried, and it was found that one of four and one-fourth inches diameter, was what may be called the neutral size over an aperture of two and three-eighths diameter; as, when it was balanced it would just adhere to the seat when the air was admitted, but the least weight placed in the scale raised it. Valves of any size smaller than this did not adhere to the seat, and would therefore be proper valves for such a pipe.

A conical valve was now procured, the greatest diameter of which was six inches on the upper side, and its least diameter was two and three-eighths inches, the same as the aperture, and its thickness one and a half inches. This valve being fitted into a proper seat, required as many ounces fitted to raise it from its seat as the flat six inch valve did. See fig. 4.

Another conical valve, whose greatest diameter was the same as the flat neutral valve, four and a half inches, its least diameter two and three-eighths, and its thickness three inches, was fitted like the preceding one, into a seat of equal thickness with itself. This valve, however, if less than six ounces in weight, was blown off by the blast. And thus it appeared, that a conical valve, may be less disposed to adhere to the seat than a flat valve, the diameter of the upper sides of both being the same. See fig. 5.

A phenomenon, singular in appearance, was exhibited while using these conical valves. It became necessary to fasten a seat with a hollow cone to the flanch, and, in the experiments, the issuing stream of air was made to pass between the cone and its seat. But when this seat was liberated from the flanch, and the stream of air suffered to flow, one stream rushed between the cone and the seat, and another between the seat and the flanch. And thus the seat of the cone was held in its situation by the two streams of air, without being in contact with any thing else.

During the experiments burning paper was placed on the valves, that the flame and smoke might show whether there was any atmospheric current rushing down upon it. But it was only at the periphery that the flame was drawn down, until it came in contact with the stream of air issuing from under the valve, which cut off the flame as abruptly as it could have been cut through with a knife, apparently from its force and coldness. On the valve the flame

blazed in the way in which it ordinarily does, when there is no current of air acting upon it.

In endeavouring to account for these phenomena, it appeared that the air in the aperture was projected or driven from the aperture as from a centre, in radial lines in every direction through enlarging circles, and thus became attenuated as it was thrown off from the centre, in the way that light is diminished according to its distance from its radiating point. For the purpose of ascertaining whether this was a correct view, or not, another experiment was made.

Instead of a circular valve, one of the form of a cross was used, six inches in diameter, of which fig. 6 is a plan. The centre of this cross valve just covered the aperture *b* in fig. 1, and the four arms *l*, *l*, *l*, *l*, extended to the diameter of six inches. The four angular spaces between them left on the seat of the valve were covered with pieces of wood *m*, *m*, *m*, *m*, fitted to the spaces and fastened to the valve seat, leaving the cross valve at liberty to be raised between them. By this contrivance the compressed air, on issuing from the aperture, was confined to four separate streams of equal and uniform breadth, which could not diverge, but passed under the cross until they escaped at the ends of its arms. The tubes with mercury, as in fig. 1, having been inserted in the arms showed not more than one-eighth of an inch vacuum in any part of the arms, and less towards their outer extremities; and this small vacuum probably was the result of some air making its way under the angular pieces *m*.

The cross was now raised enough to leave considerable spaces for the stream to expand from its previously compressed state, and to become rarified, but no greater attenuation was indicated by the mercury. And thus it appeared, that when there was but little space, only 1-32nd of an inch, under the circular valve for the air to be projected into, there was an attenuation, or partial vacuum of $1\frac{3}{4}$ inches of mercury, but when the cross valve was gradually raised from 1-32nd to the height of half an inch from the seat, and when of course there was ample room for expansion, not more than 1-8th of an inch vacuum was indicated.

From these various phenomena it appeared that the vacuum under the circular valve was produced by the spreading of the air from a smaller to a larger circle, immediately after it left the aperture. For on the air being prevented from spreading by the pieces of wood *m*, fig. 6, when fastened to the seat of the valve, the vacuum nearly disappeared in the streams under the arms of the cross valve; but by attaching the angular pieces to the cross valve, and suffering both to rise together, the full vacuum of $1\frac{3}{4}$ reappeared as with the circular valve.

When the circular valve *d*, in fig. 1, is placed on the seat, there is stagnant atmospheric air within the aperture *b*. On the condensed air being admitted into the pipe *a*, the stagnant air is put into motion, and before it can overcome the inertia of the valve, is forced between the outer parts of the valve and its seat. The air, while being thus forced is, however, compelled to diverge from a circle, whose diameter is two and three-eighths to one of a larger diameter,

and is consequently dilated and attenuated. The impulse given by the compressed air on its first admission to the stagnant air in the pipe, causes the stagnant air to commence the process, but the compressed air follows instantaneously, and through the force with which it is impelled by the original moving power, is projected under the valve, and there forced to diverge with a velocity proportioned to the amount of the projectile force.

The projectile force acting through the stream of compressed air, and the peculiarly shaped and confined space through which the air is driven, are then the causes of its dilatation, until its degree of rarity is beyond that of the atmosphere, when atmospheric pressure on the upper side of the valve preponderates.

This view will, perhaps, be illustrated by supposing the compressed air at the edge of the aperture, to be an elastic ring of two 3-8ths diameter, and that every part of this ring shall be struck with equal force from the centre, in a radiating direction to the circumference: by the time that the ring is projected to a sufficient distance to be a diameter of, say four inches, it will be stretched from a smaller to a larger circumference, and every part of the ring will be equally stretched or attenuated. A part of such a ring may be supposed to be represented in fig. 7. It is not, however, necessary that the substance projected should be elastic, for if the ring were made of lead, the effect would be the same; or if grains of sand, or small lead shot, could, in like manner, be thrown from a centre, in all directions around, it is clear that as they were removed farther from the centre, the grains or shot would be more distant from each other, or the stream of them would be more attenuated.

By a reference to the curve fig. 3, representing the degrees of vacuum, it will be seen that the circle of greatest vacuum is near to the aperture; and it may be inferred, that this fact is opposed to the theory of forced divergence, as on that theory it may be thought that we ought to have the greatest vacuum where the divergence was the greatest, and consequently near to the periphery of the valve. But it should be borne in mind, that the issuing stream of air has to overcome atmospheric resistance; and when, by diverging, it has become rarer than the atmosphere against which it is acting, the momentum requisite to keep it so is soon expended, and the stream under the outer parts of the valve not having sufficient force to overcome atmospheric resistance from without, yields to it, and is brought to common atmospheric density. If the velocities of the stream under the different parts of the valve could have been ascertained by stages of thirty-secondth parts of an inch, in the same way that the degrees of vacuum were found by the heights of the mercury, it is presumed that this point would have been established by experiment, instead of being left dependent on an inference.

The moving of the circle of greatest vacuum outwards, as the valve was elevated, does, however, exhibit evidence of the justness of the inference. When the valve was but little raised, the force of the stream was expended in diverging a part of itself, near to the aperture, but when the valve was considerably raised, the superior densi-

ty of the stream was not confined to that part immediately over the aperture, but showed itself also between the valve and a part of its seat. When it was raised half an inch, the same point *h*, which in fig. 3, shows the greatest vacuum, indicated a pressure of a quarter of an inch of mercury, while the circle of greatest vacuum, had removed farther from the aperture.

It has been suggested, that the formation of the vacuum may be accounted for from the known tendency of a compressed spring when liberated, to fly beyond the point at which it will finally settle. But this action of a spring is only one instance of the operation of a general law of nature which is applicable to all bodies. When any body, elastic or non elastic, is put in motion, its inertia causes it to continue in motion in the direction in which it has been impelled until its force is expended. The force of a liberated metallic spring is expended in the effort to overcome the tenacity of the substance of which it is composed, while the force of a cannon ball, fired into an earthen bank, is expended on the resistance presented by the earth; but it is projectile force that is expended in both instances.

In a short time after the phenomenon of the adherence of the air valve was observed by Mr. Roberts, he ascertained, by experiment, without knowing that it had been done before, that *water*, when forced through a conical pipe, with considerable velocity, will draw out other water, placed below in an open vessel, if one end of a small tube is inserted in the conical pipe, and the other end is immersed in the water, in the vessel below: thus showing that water, an inelastic fluid, produced the same effect that air did, when rushing out in a stream, confined in a peculiar manner. And at the time this paper was going to press, water was, by pressure from a column of considerable height, made to issue from a pipe with a valve placed over it, similar to what is exhibited in fig. 1, when the valve, instead of being forced off by the issuing stream of water, was found to adhere to the seat, at a small distance from it. And when the apparatus was inverted, and the valve consequently placed below the seat, upon the water being permitted to flow, the valve, instead of obeying the law of gravity and falling by its own weight, or of being driven off the force of the stream of water, adhered, with considerable firmness, to the seat.

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## ¶ On Working Iron and Steel.

[Continued from p. 123.]

### *On Steel.*

Steel is made by combining carbon with iron: it is done by immersing the iron in carbonaceous matter at a white heat and excluded from air, till it has imbibed enough all through. It is made to receive more or less, according to its intended use. Pure iron is not altered nor increased in hardness by sudden cooling from a red heat; but the small quantity of carbon which is combined with it to form steel, greatly increases its strength and toughness, leaving it both malleable

and ductile, and gives it that peculiarly valuable property of becoming extremely hard, if suddenly cooled from a red heat by immersion in water or by any other means. With this first dose of carbon it is called *mild steel*, because it possesses all the valuable properties of iron, with increased strength.

A larger quantity of carbon increases the hardness of the metal, and makes it more brittle when hardened by sudden cooling, and also renders it fusible; therefore it is called *cast steel*, and being less malleable, it is more difficult to work.

When steel is made without fusion, by immersing it in carbon, the process is called *cementation;* and it is called *blistered steel*, because, while the carbon is entering, it meets with oxygen, or hydrogen, or other impurities, which it causes to become gas or vapour, and this blisters the steel. There is a considerable quantity of steel brought to market with defects which appear to be the remains either of these blisters or of the weldings that follow.

Cast steel, being made by fusion, admits of an equal distribution of carbon, and of the escape of every particle of gas, vapour, or any other substance not compatible with it at so great a heat, leaving only such as can combine with it; therefore it is the only steel we can be sure of obtaining quite sound.

The question whether steel contains any thing besides carbon and iron, is chemical. A good workman only requires metal perfectly free from flaws, and quite homogeneous, and that will harden at the lowest heat; for this last test supersedes all others in proving the goodness of steel and its fitness for the best purposes.

The soundness of cast steel renders it most desirable to use; but the excess of carbon makes it too harsh, and therefore more difficult to work; but by frequent heatings and hammerings it may be reduced to the state of mild steel, the excess of carbon burning out while forging, and then it must be the best steel for general use. Yet shear steel predominates in the market, and more particularly in the various manufactured tools, probably from being cheaper. Therefore it is desirable to discover its faults, the better to cure them.

Perfectly pure iron cemented in pure carbon would probably make steel without blisters; but as in practice blisters are produced, there must still be oxygen in the iron, or some other substance that is turned into gas or vapour by the addition of carbon. Now, the blisters are mostly on the outside, but why not equally throughout? The answer is, the strength of the metal resists the assumption of the gaseous or vaporous state. Is not, then, the blistered outside purer or better steel than the centre? for though the carbon penetrates to the very centre, is it not obliged to combine with the oxide of iron and other impurities in the solid state, and remain so, the strength of the metal forbidding the change by which it would have a chance of escape? Again, if permanent gas is formed in any of the small blisters within, how is it to escape? the hammer may greatly reduce the size of such blisters; but will there not be small flaws or cavities remaining? If, in addition to this, the iron contains the bases of the earths or alkalies, or the earths themselves, these latter may be reduced by the

joint action of the carbon and iron, and then being vaporised by the heat, the metal may be blown into blisters. In this case the cavities would probably be coated and thus rendered unweldable; these flaws would then spread with the metal while working into plates or rods, and the mass, though close, would not be united.

The blistered steel must be unequally carbonised, the outside containing most; it is fitted for the market by drawing out to greater lengths by the hammer, then folding double, and welding together again; then drawing out, and again welding several times. This mixes the various parts together, and thereby distributes the carbon more equally, and condenses the metal; it is then called *shear steel*, and considered fit for use. Now, these weldings are liable to introduce flaws,—first, by imperfect union; secondly, by the carbon burning out of the surfaces that meet together, giving a stratum either of iron or of steel with less carbon; and these being softest, would give way during the extension of the steel.

Now, whether from original blisters, or similar cavities from imperfect welding, such defects do very largely accompany this steel; and it is a question, whether any process short of fusion can totally remove them. Yet long continued forging greatly improves the soundness and homogeneity.

Besides flaws, there is another defect often met with in steel, it is said to have pins; for, when filing or turning, it appears to have knots or pins in it harder than the rest of the metal. A similar defect occurs in brass, when, through the negligence of the founder, it contains iron or steel filings; also in wood with hard knots: but this evil is worst of all when it occurs in steel, which naturally is hard to work. I have met with it in all degrees, from mere harshness up to real hardness; so that while turning in the lathe, these parts would remain projecting out, and damage the tool rather than be cut away. I have filed some off, and then found their hardness nearly approach that of the file. This inequality of hardness causes the work and tool, though held by the rest, to spring away from each other, rendering it difficult to turn true. I think it is often caused by portions of the metal being over-steeled, *i. e.* so completely charged with carbon as not to soften by slow cooling. Another cause is stated by Mr. Clement, who broke the steel across these pins, having filed away the back to render it weak enough to part at the right place, when he found a cut or division, on which account he attributes the flaw and its hardness to oxide of iron, which prevented the parts from welding together; and as oxide of iron is known to be harder than steel, by its being used for polishing that substance, it most likely will cause hardness where it occurs. It would be desirable to ascertain the state of the surface of the deepest blisters, to know whether they are alloyed or oxidised, or in any way differing in their state of carbonization from the most solid parts. When such spots occur from oxygen, the adjoining parts must be iron; for there will be a gradation from oxide through iron to the steel, therefore the circumference of such a spot would be softest.

An excess of carbon renders steel harder and more brittle, there-

fore inequality is liable to occur. This is illustrated by iron hardened while casting; and of that which is intended to be soft, portions are frequently found hardened by the wet sand: these parts near the outside break with a more glassy fracture than hard steel. Good steel, hardened by plunging from a red heat in cold water, will always become soft by slow cooling from such a heat; but this hard cast iron does not: it requires burning several hours at a red heat, and must not be smothered by fuel to prevent decarbonizing, but, on the contrary, should be exposed to the current of air, that some portion of the carbon may burn out while the remainder has a tendency to equalize itself; then, if slowly cooled, it is found soft. Now, the knots or pins in steel are not softened by slow cooling, and to burn them out would spoil the steel, it having no carbon to spare but in the pins (supposing this to be the cause of their hardness); and keeping it hot in close vessels will not produce equality sufficient for any good purpose. Even cast steel is liable to long veins of harder portions than the rest. All these defects show the need of farther attention to the improvement of steel, and for this purpose two sorts of hammering are requisite.

The first should be at a forging heat, to knead the parts, and keep them moving among themselves almost like a paste; and should be continued till the different qualities are not only intimately mixed, but, if I may use the expression, really dissolved in each other, producing perfect homogeneity; for the carbon being thus spread, will discover every particle of oxygen, and (it is supposed) will expel it, and the metal will be rendered as sound as we can expect from cemented steel; for if free from oxygen and all alloys, except the carbon, there is nothing to prevent a perfect union of all the parts while under the hammer. Good steel consists of that proportion of carbon and iron which forms the strongest and toughest compound; each best portion, therefore, when brought into contact by the hammer, remains so, and resists its force the more from the greater cohesion of its particles; hence the redundant or deficient portions suffer most kneading, till they are all equalized, and the cruder impurities are either beaten out, or formed also into a homogeneal compound with the whole mass.

Having thus far obtained sound steel, it is yet by no means in a good state, being very unequal in density, and in a state of distraction—some parts close and dense, others squeezed out, and some nearly rent asunder; therefore a second hammering is necessary at a particular heat, and under circumstances as similar as possible to those described in the former part of this paper; such as recesses in the anvil, or in blocks laid thereon, suited to the shape of the steel.

For this purpose the metal is first brought as near as eligible to the size in which it will be used, and then is to be hammered in order to close and condense the metal equally and to the utmost all through, and yet leave every part in a state of rest and ease—a condition extremely essential for good springs, sword blades, musical wire, and every thing that has to vibrate, or act by its tension; for if one part is denser than another, or more at ease, the weaker parts

will have most, if not all of the play, and will soon break. And that this is not so often noticed to be the cause as it should be, is shown by the crudeness of the cure. If a spring breaks, it is frequently replaced by what is called a stronger, that is, a heavier one, losing a portion of the play, and what remains being still upon the weakest parts; so that though it may last longer, yet it ultimately breaks. This may also account for the breaking of axletrees that have appeared sound; for they are subject to such violent shocks as to require every part to yield equably; for the axiom, that the strength of the whole is only that of the weakest part, rendered less so by the weight and stiffness of the stronger parts, is as truly applicable to springs as to ships.

This second hammering is also to prepare the steel for receiving the utmost hardness, by that peculiar property which it alone possesses—namely, that of receiving a brittle hardness when suddenly cooled from a red heat; but though this hardened steel is brittle, its toughness greatly exceeds that of any other brittle substance.

It is this quality that makes it completely the *master metal*, the one by which we give shape and form to all the others, and fit almost every thing for our use. I must here observe, that this hardness cannot be given in part, it must always be given in full; and so true is this, that in a piece of steel, part of which is hard and part soft, no gradation of hardness can be detected; the soft parts adjacent to the hard ones being quite as soft as any others; indeed, so much so, that they have been thought by some to be softer than if slowly cooled. This appearance may be accounted for in the following way: Suppose a rod of well hammered steel is heated at one end for hardening, there will be a gradation of temperature from the coldest to the hottest end, and the annealing, or reduction of that hardness which it has received from the hammer, will be in proportion to the heat, consequently the rod will be softer and softer towards that end where the heat is applied. On plunging the bar into cold water, that portion which had become hot enough to harden becomes quite hard, and close adjacent to it will be found that part which having been the most annealed, will bear twisting and bending more than any other. But though this hardness must always be given in full, it can be let down in any assignable degree; that is, a portion of its brittleness may be removed by a moderate heat, and a greater portion by more heat, and so on, as the purposes may require. This is called *tempering;* and if hard steel be brought to a red heat and suffered slowly to cool, it becomes as soft as if never hardened; it is then ready for re-working or re-hardening. This is called *softening*, and is distinguished from *annealing*, which is the same process of slow cooling but applied to steel, iron, or brass, merely to remove all mechanical condensation, whether by hammering, flatting, wire-drawing, bending, or any other work; for if metal has been altered in shape by the hammer or other work as much as it will bear without breaking, then by annealing, it will be softened, and may again be bent or altered as much more; and so on, as often as requisite. Now, as different degrees of heat remove different degrees of

condensation received from the hammer, and a white heat removes all, it is of great consequence to harden from the lowest possible heat, in order to retain as much condensation as may be; and it is a fortunate coincidence, that the greater the condensation, the lower is the heat from which steel will harden, and the stronger and tougher will it be. But should this condensed metal be once over-heated, it will no longer harden from that lower degree, but only from a heat near that to which it has been raised; its condensation, with the advantages dependent on that quality, can only be restored by re-hammering. The lowest heat at which steel is generally brought to harden is a dull red, just visible in daylight. Therefore, to be safe, a dull red, only visible in the dark, is chosen for the hammering. At this heat also it can be kept coated with carbonaceous matter, instead of having any burnt out, which is of particular consequence. For this purpose a smith's forge, in rather a darkish place, having its flat bed even with and near the anvil, is kept smothered with small fuel, the bellows being used only enough to keep the fire alive, so that the gas or smoke cannot burst into flame. The several pieces of steel are laid a little in the half-kindled fuel, enveloped in smoke; this coats them with carbonaceous matter, which the hammering heat can hardly dispel. They are brought in succession from the fire to the hammer, and back again to the fire when too cool; the hammer moves quick, and every part of the steel in close succession is slowly passed under it, and then (the position being changed a few degrees) it is again passed under, and so on, till it has been hammered in every direction, being often reheated; and this is continued as long as the workman thinks it can be of service. Experience teaches him to know by the feel, the sound of the blows, and the lessening degree of impression, when the steel is hammered enough. By such means, and an honest zeal for the goodness of his work, Mr. Walby, whom the society in the year 1804 rewarded for his hammer, produced the best trowels that probably were ever made; their toughness, spring, and elasticity, seemed carried to the utmost. At this heat the metal spreads much less; but yet, unless confined within a recess so as entirely to prevent spreading, the outer band will be so bad as to require cutting off, it will be so stretched and rent by the pressure of the inner portion.

[TO BE CONTINUED.]

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*On the utility of fixing Lightning Conductors in Ships. By* W. S. HARRIS, *Esq. Member of the Plymouth Institution.*

1. A THUNDER-STORM is the result of a great natural action subsisting between an extensive stratum of cloud, and a corresponding portion of the earth's surface, together with the intervening atmosphere; and is the result of some powerful agency, the nature of which is as yet undiscovered.

2. The active principle of a thunder-storm, however, may be considered as an extremely subtle species of matter, universally perva-

ding nature, and distributed in bodies, in quantities proportionate to their capacities for it, so that when accumulated in and about certain bodies, and abstracted at the same time from other bodies, a tendency to regain the previous state of proportionate distribution is marked by a certain train of phenomena; thus, a concentrated action is frequently set up between the overcharged and undercharged bodies, which produces all the effects of a violent and terrific expansive force, for the original state of proportionate distribution is often restored by a rapid explosion, at which instant the most compact bodies are broken; whilst, at the same time, there is such an evolution of heat, that substances directly in the line of action are sometimes inflamed, fused, and ignited.

3. This easy and elementary view of electrical action may not be altogether useless; for to investigate any branch of physical science with success, it is always advantageous to arrange our ideas in some determinate order, by means of which the details assume a clear and connected form; for although it must be admitted, that every theory is merely a way of picturing to ourselves the course of nature, it may be always sufficient, and admissible, so long as it is consistent with the observed phenomena, and not contradicted by any known fact.

4. In the progress of electrical inquiries, it has been found, that some substances oppose but comparatively little resistance to the passage of the electrical agency, whilst, on the contrary, other substances seem to arrest its course altogether; a fact which induced electricians to consider bodies as possessed of these peculiar properties, and to classify them in relation to this *conducting* or *non-conducting* power. Substances which oppose but comparatively little resistance to an electrical explosion, have therefore been termed *conductors*, whilst those which offer resistance to its progress, have been termed *non-conductors*, or occasionally, from the same cause, *insulators*. In the conducting class, we find all the metals, concentrated acids, water, well-burnt charcoal, wood, diluted acids, and saline fluids, most earths and stones, flame, smoke and steam. If any of these substances resting on the ground, be put into contact with an electrical machine, whilst a current of sparks is passing from it, the sparks will immediately cease; in consequence of the electric matter being transmitted by them to the earth—an easy and striking experiment. Non-conductors of electricity, or insulators, are all vitreous and resinous substances;—dry, permanently elastic fluids, such as air, baked wood, silk, pure carbon, and most precious stones, oils, dry vegetable substances, as also, dry marble, chalk, and lime, wool, hair, feathers, dry paper, parchment, and leather. If, whilst a current of sparks is passing from the electrical machine, any of these bodies be put into contact with it, and rest as in the former instance on the earth, little or no difference will be perceived, the sparks will continue.

5. Although for general purposes, the various bodies in nature may be considered as belonging to one or the other of these classes, a gradation of effect is observable from one class to the other; so that the conducting or insulating power of some substances, compared

with that of others, may be considered as imperfect: hence has arisen a third class, which consists of the remote* extremes of the other two, and which may be considered, in the power of arresting or transmitting certain electrical actions, as appertaining to either. Thus wood, hemp, stone, and the like, may become insulators to a state of low electrical action, and conductors to a high one.

6. The manner in which accumulations of atmospheric electricity proceed, may be referred to the following principle: When two substances of the conducting class are directly opposed to each other, and are separated by a substance of the non-conducting or *insulating* class, leaving the one free and the other insulated, the proportionate state of electrical distribution may become deranged to the greatest possible extent. Now, in nature, the conditions of such an experiment are found in the relative situations of the sea and clouds, and intervening air; so that when, from any cause, an evolution of natural electricity takes place, and heavy masses of vapour are present in the atmosphere, we have immediately an insulated conductor (a cloud,) directly opposed to a conductor in a free state, (the sea or land,) and an intervening non-conducting or insulating medium, the air; hence results a charged battery of enormous power: the attraction of the opposite electrical states, therefore, may become at length so powerful, that the electric matter breaks down the intervening resisting air, with a terrific and dense explosion—an effect perfectly analogous to the explosion which frequently occurs at the time of conveying a high charge to an electrical battery, and which is attended by a peculiar fracture of the interposed glass.†

7. The year 1752, which marks an important era in electrical science, from the celebrated discovery of the principle just mentioned, under the form of the Leyden jar, gave to the natural philosopher an easy method of concentrating large quantities of electricity produced by artificial means, so as to discharge it upon or through bodies with an instantaneous and violent explosion. From the time, therefore, that the cause of lightning became *identified* with that of ordinary electricity, and that the gigantic attempt of Dr. Franklin and other philosophers, of actually drawing down the matter of lightning from the clouds, was fully accomplished, the effects produced on bodies by these minor electrical discharges, with their mode of action, acquired a new interest; and many important experimental researches into the laws and operation of the great natural action, were successfully carried on by means of the ordinary artificial one.

8. Amongst the many important results arrived at by such inquiries, are the following:—

*First*, In every case of electrical explosion, there are universally two points of action, one *from* which the electric matter may be sup-

* Would not the term *proximate* be more appropriate than *remote*, those extremes which most nearly approach each other being manifestly intended.—Editor F. J.

† An explanation of some of the phenomena of thunder-storms on this principle will be found in my printed letter to Sir T. B. Martin, K. C. B. Comptroller of his Majesty's Navy.

posed to proceed, and another *towards* which it may be considered as determined.

*Secondly*, At the instant before which an explosion takes place, the stream of electricity moving to restore the equilibrium of natural disposition, seems by a wonderful influence to feel its way, and mark out as it were, in advance, the course it is about to follow; which course is *invariably determined through the line or lines of least resistance* between the points of action.

A few illustrations from experience of damage by lightning, may serve to render these facts evident.

(*a.*) The brig Belisle, of Liverpool, in November, 1811, was lying afloat, abreast of Mr. Evan's yard, at Bideford, when a vivid flash of lightning shivered her fore-top-mast and fore-mast, tore up the forecastle deck, and struck a hole through her starboard side, starting several butts in the bends, whence it passed into the sea.

(*b.*) The French ship Coquin, at anchor in the bay of Naples, was struck by lightning in the afternoon of Christmas day, 1820. The electric matter passed, in this case, close to the main hatchway, upon a spare anchor, and from thence through her bottom, a little below the water's edge on the larboard side. The boats of the squadron in Naples Bay, assisted to slip her cables and run her ashore in the mole.

(*c.*) The United States ship Amphion, Blone, master, of and thirteen days from New York, bound to Rio, was struck by lightning on the 21st of September, 1822. The lightning descended by her mizen-mast, destroyed the compasses and cabin furniture, splintered and tore to pieces the ceiling, bulk-heads, and rudder trunks, shivered two hold beams, and passed out through the quarter into the sea, tearing off part of its sheathing in its course.*

(*d.*) His Majesty's frigate Paima, commanded by Captain Worth, was struck by lightning in 1814, in the harbour of Carthagena, Spanish America. The fore-top-mast was knocked over the side, the lightning guttered or scooped its way, two inches deep, and one inch and a half wide, under the hoops of the mast, without injuring them, as far as the main deck. Here it fell upon the wet cable which had been just shortened in, and was lying against the after beam; it knocked out a piece of the beam, and passed by the wet cable out of the hawse hole, the lead of which bore evident marks of the explosion. It was perfectly calm at the time, and the lightning, besides striking the ship, *struck also down upon the sea* several times, and within a short distance of the ship.

(*e.*) The packet ship New York, in her passage from New York to Liverpool, was struck by lightning twice in the same day, April 19, 1827. The first explosion shattered the main-royal mast and mast-head, penetrated the deck, and demolished the bulk-heads and fittings in the store-rooms below,—then dividing, one part fell upon a lead tube, which it traversed as far as the side of the ship, and passed out into the sea, starting the ends of three four inch planks;

* Extracted from the log of the brig Mirabiles, and given to Mr. Lockyer, Comptroller of the Customs at Plymouth.

another portion passed into one of the cabins, and shivered to atoms the plate of a large mirror, without hurting the frame; after this, it fell upon a piano-forte, which it touched with no very delicate hand, and left it dismounted, and out of tune; from thence it passed through the whole length of the cabin floor, which was damp at the time, and out of the stern windows into the sea.

(*f*.) The operation of the second explosion was very different from this;—it fell upon a spike at the mast-head, and from thence passed down a small metallic chain, which it disjointed and partly fused, into the sea, without doing any damage to the vessel.*

(*g*.) His Majesty's ship Bellerophon, under the command of Captain Rotheram, was struck by lightning at sea, in August, 1807. A violent explosion took place in several parts of the ship at the same time; the main-top-gallant mast totally disappeared, except the heel; the rigging of it was cut and burned in pieces; main-top-mast shivered in splinters from head to heel; main-mast damaged, and thirteen feet of the fish on the fore-part disappeared. The explosion also fell on the mizen-top-mast, which it likewise shivered; it descended down the mizen-mast in a spiral direction, broke the hoops, and damaged the mast; it passed through the coat of the mizen-mast on the larboard side, and through one of the poop beams on the other side; it passed into the ward-room, into one of the officer's cabins, started the butt end of a plank in the ship's side, and split a rider underneath, on the lower deck. The electric matter on the larboard-hand went close into the ship's side, in a perpendicular direction, and through the main and lower decks; it cut the clamp of the main-deck beams, entered the steward's room, where it ripped up the tin lining, and then passed through the orlop-deck into the butter room. The vessel was not damaged in the final escape of the electric matter into the sea.

(*h*.) In January, 1830, H. M. S. Etna, under the command of Captain Lushington, was struck by lightning in the Corfu Channel, in the Adriatic, at the time of coming to anchor. In this instance three tremendous explosions came down a metallic chain, attached to the main-mast, and passed into the sea, without damage to the mast; the ship at the time seemed covered with sparks.

9. It may be observed by an attentive examination of these few cases, 1st, That the points *to* and *from* which the electric matter is eventually determined, are out of the ship; and, according with what has been stated in 1, 2, 6, are in the clouds and sea, so that the vessel is merely, as it were, an intervening object; the only action, therefore, which can be conceived to belong exclusively to the ship, is that which may be required to neutralize the opposite electrical state, induced upon the whole mass of the vessel, as being a point of the great surface opposed to the electrified clouds, and which is very small and of little consequence, compared with the capacity of the surrounding sea. Cases *a*, *b*, *c*, *d*, *e*, *f* more particularly show this. 2ndly, That the points through which the explosion is determined,

* This conducting chain had been set up immediately after the first explosion happened. See vol. 2, p. 63, of this journal.

are invariably in the line or lines of least resistance between the points of action—that is, through the best conductors. Cases *d*, *f*, *h*, clearly illustrate this; and the same may be traced in all the others.

10. It may be also observed in these, as in every other case of damage from lightning, more especially on shipboard, that the greatest mischief occurs where good conductors cease; the electric matter being then enabled to produce all the disastrous effects of an expansive force, as if, whilst in the conducting body, it was in a diffused and low state, and again condensed and brought into a narrow focus, at the moment of leaving it. The damage, therefore, may be in this case considered to happen, not where the best conductors *are*, but where they *are* not; so that the mariner has to contend with a constantly exploding principle, which continues its devastations in all those points where it ceases to be transmitted; thus determining for itself a passage between the points of action through such line or lines as may, upon the whole, oppose to it the least resistance.

11. Such effects being constantly observed not only on ship-board, but on shore, it became a grand question of scientific consideration, how far it would be prudent to provide for the electric matter an efficient conducting line, between the highest points of a ship and the sea, so as to offer the least resistance to the progress of such powerful agency, and transmit in a state of low tension between the points of action; on the same principle that persons, dreading an inundation, would provide a channel to carry off the water as easily as possible; an idea, as is well known, first suggested by the celebrated Dr. Franklin, and since carried into practice with considerable success; the conducting line having the name of lightning conductor or lightning rod.

[TO BE CONTINUED.]

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*Report on the present state of the New London Bridge. By Mr.* CHRISTOPHER DAVY, *Architect.*

To the Editor of the Mechanics' Magazine.

*Furnival's Inn, Feb. 27*, 1832.

DEAR SIR,—Having on the 20th inst. minutely surveyed along with you the present state of the new London bridge, I now proceed, agreeably to your request, to state the result of that survey for the information of the public.

A very considerable degree of subsidence is always to be looked for in structures of this magnitude; and wherever such subsidence possesses one uniform bearing, there is little, if any thing, to be feared from it. In laying out the working plans of the new London bridge, it was inferred, from the soundings that were previously made, and from what had taken place in the case of the Southwark and Waterloo bridges, built over the same river, and at no great distance from the site of the present, that the centre arch and pier might settle nine inches, and each of the others eight inches; and Sir

John Rennie states, that the actual settlement falls short of this calculation, (Report to the corporation of London, Nov. 17, 1831.) It cannot be said, however, that the bridge has yet reached its actual bearing; neither is the real state of matters correctly represented, by speaking of the subsidence as merely vertical.

From the survey which we made, it appears clearly that a settlement has taken place in three different directions. The first is the perpendicular settlement of the bearing piers into the bed of the river. The second is a longitudinal settlement of the superstructure from south to north. The third is what may be called a transverse settlement of the entire structure from west to east, that is, sideways, in the direction of the stream.

The effect which these different subsiding tendencies has had on the form and appearance of the bridge, will be found accurately represented in the accompanying drawings.

*Fig.* 1.

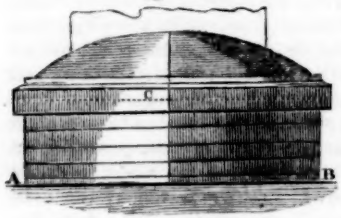



*Fig.* 2.

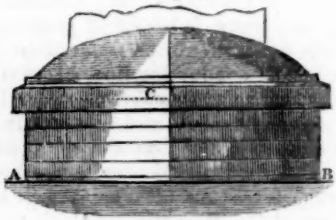



*Fig.* 3.

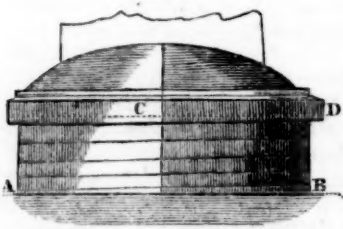
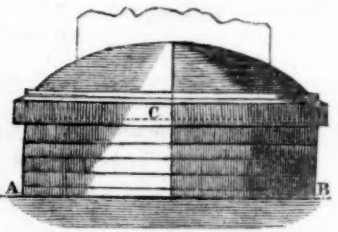



*Fig.* 4.




Figs. 1 to 4, represent the present elevation of the cutwaters of the different piers, beginning from the Southwark side. The dotted line, C, is a perfect horizontal line, drawn from the corner of the platband, or string course, D, of the first bearing pier on the city side, through all the others, in order to show how the piers have sunk, compared one with another. The lines A B, drawn through the different cutwaters, show how much each pier deviates from the true level. We measured accurately the height above the water (at half flood) of each of the first course of stones, at the points A and B, and found the following extraordinary variations:

| Fig. 1. | Fig. 2. | Fig. 3. | Fig. 4. |
|---|---|---|---|
| A $4\frac{3}{4}$ inches. | $5\frac{1}{2}$ | A $8\frac{1}{4}$ | 6 |
| B $5\frac{1}{4}$ | $6\frac{1}{2}$ | B 6 | 9 |

The pier and cutwater, fig. 1, has evidently been the first of the series to settle downwards; and this can only be accounted for from the lesser density of the soil on the Southwark side of the river. The south bank of the Thames was originally at this place a vast marsh or swamp, while on the city side, the ground was firm, and rose somewhat abruptly from the river. In 1823, the whole of the river bed at this part was bored under the directions of Mr. Telford, by order of the Bridge-House Committee; and the borings then made, showed that the rubbish and loose soil on the Southwark side, reached considerably below the level to which the tops of the bearing piles of fig. 1 have been driven. It has been stated, indeed, by the engineer, the assistant engineers, and contractors, that "every one of the piers was founded on very hard solid clay;" nay, that a considerable thickness of it was removed to get to the depth at which the foundations were laid: (Report of Messrs. Telford and Walker, October 17, 1831,) the excavations, too, were made within coffer dams, so as scarcely to admit of any mistake about the nature of the ground; but if the soil on the south bank were not of inferior density—something far short of "very hard and solid," how is the greater sinking on that side to be explained? I am not aware of any other explanation that can possibly be given.

The piers figs. 2 and 3, being those on which the centre arch is raised, incline towards each other; and this would seem to arise from the current being much stronger, and of much greater depth in the centre of the river than towards the sides, and from a consequent leaning to the side of least support. Sir John Rennie states, that the piers are protected from the action of the stream by "three complete rows of sheeting piles, fifteen inches square, and driven 18 feet into the ground (in addition to the bearing piles,) and extending round them for a distance of thirty feet;" and, moreover, that "the bed of the river for the same distance, is three to four feet *above* the platforms, and two feet eight inches more above the heads of the bearing piles," (Report November 17, 1831.) But on the other hand, Messrs. Telford and Walker have reported that from their "soundings in the middle of the centre arch, the bed of the river at that place is now about two feet six inches under the level of the top of the platforms." (Report October 17, 1831.) We are constrained, therefore, to conclude, that since the bearing and protecting piles were driven in, the bed of the centre of the river, must have been scooped out to the depth of some six or seven feet; and this would indicate a violence in the scouring operation of the stream, which could not fail, in spite of the protecting piles, to affect very materially the solidity of the foundations, laid bare to its action. It seems probable that this result has been very much accelerated by the circumstance of the greater part of the piles which supported the centring of the middle arch, having been subsequently withdrawn, and the soil having been thus necessarily broken up and loosened to a great depth. It is deserving of remark, that in the only other bridge over the Thames in which this plan of raising the centrings was exclusively followed—namely, that of Westminster—a similar

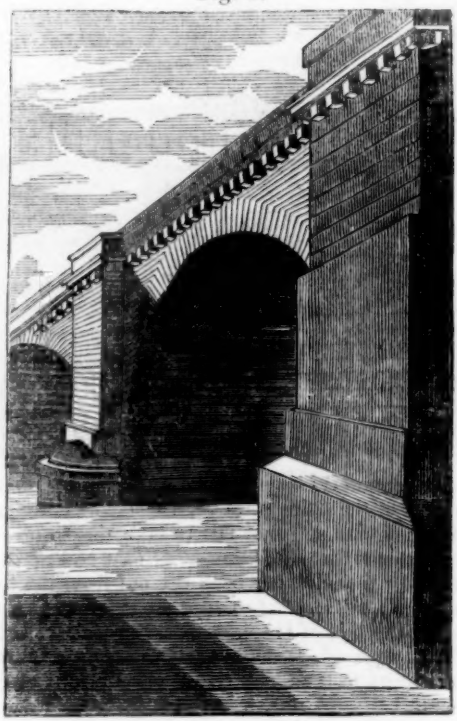
failure took place; and that, although the piles were not wholly withdrawn, but sawn off under water. The centrings of Blackfriar's and Waterloo bridges were supported on the offsets or footings of the piers. In the case of the Southwark bridge, the centrings were partly supported on the offsets of the piers, and partly on piles driven into the bed of the river—a combination of means called for by the great span of the arches; but the piles were at such a distance from the piers, that the subsequent extraction of them did little if any harm. In no circumstances, however, can the withdrawing of piles from such places, and the disturbance of the soil consequent upon it, be considered either safe or prudent; and least of all, where there is a deep and impetuous current, such as that through the centre arch of the new London bridge to contend with.

The longitudinal settlement or leaning of the superior part of the structure, from south to north, that is, from the Southwark to the city side, is a fact at seeming variance with the southward inclination of the foundations; but it may be explained in this way. The theory of equilibrium, as applied to elliptical arches, requires that an immense weight should rest upon the haunches—the line of the extrados at that part forming an asymptote with the springing. In practice this condition is considered to be fulfilled either by loading the spandrils with rubble, or by the more approved method followed in this instance, of building hance-walls upon a considerable portion of the extrados. The necessary effect, however, of the great sinking which has taken place in the first pier on the Southwark side (fig. 1) must have been to draw off this required weight from the haunches, and to make it lean backwards and longitudinally, instead of downwards. Nor can it seem surprising that the backward pressure of so vast a body of materials, combined with the natural thrust of the arch, should communicate its influence, more or less, to all the arches and piers throughout the bridge. I think I may, with great safety, venture to assert, that if the roadway of the bridge were taken up, and the extrados of the first arch on the Southwark side examined, the hance walls would be found in a very fractured state. External symptoms of such a result are even already extremely apparent. Several of the voussoirs at the shoulders of the arch—the very part which in the case we have supposed would be first affected—have fallen out of their places, and given to the curve of the intrados the tortuous appearance represented in fig. 6. It may be proper to observe, that this distortion is not readily perceptible when viewing the bridge from the water, and that it is only to be seen properly from the plying stairs on the Southwark side.

The extent of what I have called the transverse settlement—that from west to east—is represented in fig. 5, which is a section through the centre of the first arch, on the Southwark side. The line, C C, marks the varying height of the first course of stones above the water; at the west or upper end, it is eight and a half inches, and at the east, or lower end, only two inches. The dotted line A, is a correct perpendicular, showing by comparison with B, the present face of

the structure, how much it has fallen from its proper vertical position.

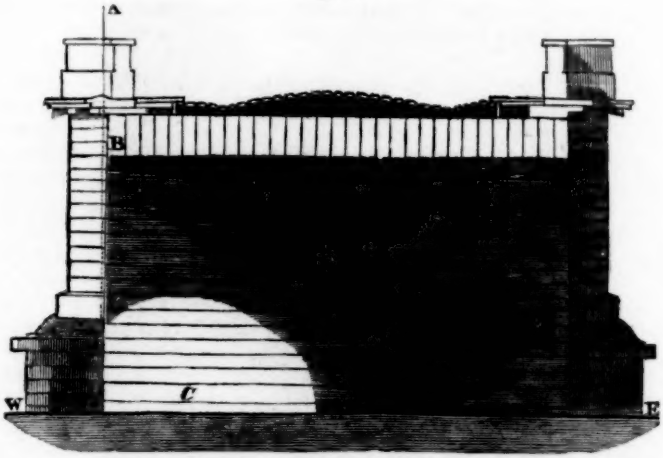
*Fig.* 6.



It appears, that from the first the east side of the bridge was considered to require greater support than the other; first, because of its greater proximity to the rapids at the old bridge: and, secondly, because the clay stratum was known to be several feet lower at the east than the west side. It was accordingly deemed expedient to cut off, and leave in, two rows of the coffer dam piling, in front of each cutwater on the east side, while the dam piles on the west side were withdrawn. But this precaution has been apparently of little avail; neither was it of a nature to counteract any tendency to depression, arising from insufficiency or irregularity in the foundations, or a want of equilibrium in the superstructure. As this transverse settlement is uniform throughout the bridge, and corresponds closely with the degree of dip in the clay stratum, it is difficult to resist the conclusion, that there is a connexion of dependence between them; though in what particular way the deviation from the horizontal line has been produced must ever remain matter of conjecture. It may

probably have arisen from the length of the bearing piles not having been graduated according to the dip of the strata.

*Fig. 5.*




The resident engineers and sub-contractors, say that this transverse settlement of the bridge has been caused by the first platform having been "laid with a small fall to take the water towards the pumps, which were fixed at the lower or east end of the first pier, and that the other piers having been set out from the first one have the same inequality;" and they add, that "the stones, after having been dressed at the Isle of Dogs, came up in pieces ready to be set, and so perfectly squared, that the variation from a level in the platform was carried up to the top of the bridge." But of this explanation, Messrs. Telford and Walker very truly observe, "it implies a difficulty of execution, which, to say the least, it is not easy to account for." "The points of the piers, the faces of the walls, and the courses of the stone work through the piers, are, with little exception, in straight lines, battering or overhanging, or sloping at the places where the irregularities are, but all nearly corresponding; that is, if the courses of stone in the piers are out of level, the ends of the piers and spandril walls to the top of the arch are nearly proportionally out of perpendicular, but still sufficiently straight, and it is not easy to suppose them to have been built so. We do not think the statement of the stones being so square, as that the work, when once begun on an inclination, naturally inclined to slope and batter to the end, without the superintendents or workmen being aware of it, sufficient to account for the irregularities to the present extent." (Report Oct. 17, 1831.)

Fortunately, the abutments at both ends of the bridge have undergone little or no variation; and should they remain firm, and the different settlements not extend much farther, no fears need be enter-

tained for the permanent stability of the structure. They will have marred its beauty, but that will be all. Were the city abutment, however, ever to fail, the fabric has such a general leaning towards that side, that it would infallibly tumble into the river.

The parapet of the bridge was not set till a considerable time after the centres were struck, and till after the settlements before described must have made considerable progress. But it exhibits, notwithstanding, very evident traces of their disturbing influence; a circumstance from which it may be inferred that *the movement* has by no means yet reached its termination. The stones appeared to us, in a great many instances, parted to a degree, which no imperfection of workmanship, or any shrinking of the mortar from the winter's frost, could possibly account for.

It is deserving of observation, that all the imperfections which have been noticed are imperfections of execution merely, and do not in the least detract from the superiority of the elliptical principle of construction. Had it been the principle that was in fault, it would have been at or near the key-stone, that we should have found failures taking place; but though we carefully examined the voussoirs and line of intrados of all the arches, we found the upper part or crown invariably firm and sound.

CHRISTOPHER DAVY.

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### ¶ *Comparative advantages of heating by Hot Water, Hot Air, and Steam.*

From minutes of recent conversations at the Institution of Civil Engineers.

Mr. Turrel said, that where steam was employed, it was requisite that a strong heat should be kept up under the boiler, in order to have a continued flow through the pipes, for as soon as the fire fell low, the steam was condensed, and they, becoming empty, were no longer serviceable for heating. With water, on the contrary, so long as there remained the smallest heat in the boiler, that temperature would be equally distributed over the whole house; the water still continuing to circulate, until it cooled down to the temperature of the atmosphere.

Mr. Simpson said, that the method of heating rooms by warm water, possessed a decided superiority over any other, from the comparative security it afforded against accidents by fire; he had known instances of hot water pipes being introduced into bankers' houses, (where they are extremely fearful of fire,) after they had objected to the use of flues, or pipes conveying heated air, or steam.

Mr. Cottam said, that no experiments had been tried hitherto, by which could be ascertained the quantity of fuel necessary to produce a given temperature on the pipe, or in the atmosphere of a room which was heated by its means. He thought it very desirable that a statement of the relative consumption of fuel should be obtained, as, in some observations on the performance of a hot water apparatus attached to a pinery, that consideration was overlooked. He could

state one instance of a house that he had fitted up with a set of hot water pipes, by which a saving of one-third was effected in the consumption of fuel; here, however, the flue, which was in use previously, had been of faulty construction; this, therefore, ought not to be considered as decisive. He stated, that no beneficial effect was produced by leading the flue from the fire, along the brick wall; there was no apparent increase of temperature in the house.

Mr. Sibley described a hot water apparatus he had fitted up, which warms several rooms, boils a cistern, and heats a bath on the top of his house; this is managed by a boiler being placed behind the kitchen fire, and which, in fact, forms the back of the kitchen range; from this a common two inch gas pipe is conducted round the rooms to the top of the house, a height of fifty feet, and returned to the boiler. He stated, that although considerable heat must be withdrawn from the fire by this apparatus, and the consumption of fuel probably increased, yet no inconvenience was felt from its operation.

Mr. Turrell observed, that he had been in the practice for many years of heating his office with a hot air stove; it was found to create an unpleasant smell, and the atmosphere of the room eventually proved extremely hurtful to the lungs. He adopted a plan of evaporating a portion of water during the whole of the time the stove was in operation, thereby keeping up a proper degree of moisture in the atmospheric air; this removed every injurious effect which was before observable.

Mr. Field said his offices were heated by means of steam pipes, and that it created a most unpleasant smell, accompanied by a feeling of oppression on the lungs. He thought the hot water pipes preferable, on account of the greater uniformity of temperature which was afforded, and always of a very moderate degree: that from steam pipes, on the contrary, was always high, and more difficult to regulate.

Mr. Clegg had been employed to correct the unpleasant smell, created by the air in coming in contact with the red hot surfaces of iron stoves. He adopted a method of covering the stove with a kind of glazed tiles, which was found to be very effective.

Mr. Hawkins had known an instance of a cotton mill, in which it was found impracticable to spin any fine description of thread, on account of the state of the atmosphere, produced by the artificial heat. A scientific man gave as his opinion, that a deficiency of moisture affected the electrical condition of the atmosphere, and was the cause of the difficulty of working the cotton into fine thread. Mr. Hawkins was of opinion that the oppressive feeling spoken of, was more to be attributed to the circumstance of a supply of moisture being necessary for conducting the electricity from the human body than to the fact of the air being burnt or decomposed.

[*Athenæum.*

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### ¶ *Method of Transferring Prints from Paper to Wood.*

Sir,—A method of transferring lithographic prints from paper to wood, was discovered sometime back in France; the process has been

imported into this country, and is at present extensively employed for the purpose of ornamenting white wood articles of various kinds, and forms a favourite amusement of the fair sex.

It having occurred to me that a brief description of the process might be acceptable to some of your readers, I beg leave to place the following at your disposal.

In the first place, the article on which the print is to be transferred, should receive a coat of spa—or, of the transfer varnish, allowing a sufficient time for it to become dry: this greatly facilitates and improves the transfer, and also preserves the wood from soil or stains during the process. Having cut away as much as possible of the superfluous paper from about the print, place it in a vessel of clean water until it is completely saturated, which will be in about five or ten minutes; then place it between blotting paper to remove the superabundant water from its surface. This done, with a flat camel's hair brush spread the transfer varnish* equably over the surface of the print, and apply it immediately to the wood; lay a sheet of writing paper upon it, and rub it all over with the hand, using pressure, that the necessary adhesion may take place.

With the fingers, dipped from time to time in water, peel off the paper by continued rubbing, proceeding with more caution as the print begins to appear. The rubbing and washing should be continued until the whole of the paper is removed; when dry, a coat of spa varnish will bring up the print.

If the article is to be polished, continue to apply the varnish until a sufficient body is obtained for that purpose, taking care that each coat is dry previous to the application of the next. When the whole is perfectly dry and hard, take pumice stone in an impalpable powder, and with a piece of serge moistened with water, polish until a smooth even surface is obtained. Then take the finest tripoli, and with a piece of fine cloth, and some olive oil, continue the process until a high degree of polish is obtained, when the oil must be wiped off with a soft linen cloth, and the surface cleaned off with starch powder, or with Spanish white.

It is but seldom, however, that persons polish their articles themselves, more patience and practical dexterity being requisite for the success of this process, than falls to the lot of every one; varnishing, is, therefore, a distinct occupation, performed by persons who make it their sole business, and who, therefore, attain great skill in the process.

In the above way all kinds of plain or coloured prints may be transferred to wood; but when coloured prints are used, it is necessary to employ an acid solution instead of water, to destroy the size which exists in all papers of coloured prints. For this purpose mix two-thirds of vinegar with one-third of water, and with it moisten the back only of the print, proceeding with the transfer as before directed.

* Prepared by George Gardom, and J. W. Williams, Philadelphia; and probably by other persons in most of our cities.

The transfer process bears a considerable resemblance to lithographic printing, and it is most likely that the idea was suggested by it. The *rationale* of the process is as follows: the paper being saturated with moisture, does not unite with the transfer varnish, but the ink being of a greasy texture is impervious to the water, and is therefore taken hold of by the varnish, and securely fastened to the wood; the paper not being so held is washed away with comparative ease, leaving the ink imprinted upon the wood.

W. Baddeley.

*London, April* 3, 1832.

[*Mech. Mag.*

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## *New Lamp.*

In the course of the first meeting, at York, of the British Association for the Advancement of Science, the Rev. Wm. Vernon Harcourt, on the 1st of October last, showed a lamp constructed upon a new principle, and explained the principle and construction of it: he gave it the name of an *oil gas lamp;* not because it was lighted by gas formed at a temperature below that of flame, (for this was common to all lamps,) but because, as in the gas lights of the streets, the gas issued from a reservoir, and owed the perfection of its combustion not to an ascending current of hot air, but to the force with which it was propelled from the reservoir and carried the air along with it. It differed from the common gas lights in these circumstances:—that the reservoir formed part of the burner; that the gas was formed as it was consumed; and that it was propelled not by a *vis a tergo*, and in a state of condensation, but by the expansive force of its own heat. In consequence of this circumstance, the current of the gaseous jet was more rapid in proportion to the quantity of matter contained in it than in the common gas lights, whilst it was also at a much higher temperature, so that it could issue with a greater velocity without being liable to blow itself out. The practical difficulty of the construction consisted in the obtaining a steady supply of oil, especially with the cheap oils. This difficulty had been in a great measure surmounted, but the instrument was still imperfect, and had been charged by some accident that evening with a vegetable oil, from which a clear light could not be obtained.*

[*First Rep. of British Asso. for Advanc. of Science.*

* At p. 188 of vol. ix. there is a description of an oil gas lamp, invented and patented by Solomon Andrews, M. D, of Perth Amboy, on the 15th of April, 1831. So far as the above article describes the "New Lamp," it appears to correspond precisely with that of Dr. Andrews. This lamp has been further improved by the inventor, who obtained an additional patent therefor on the 10th of May last. The editor has one of them in his possession which affords a brilliant and clear light, and upon which he is experimenting with a view to the testing of its comparative value, which he intends to publish at an early day.

### *Bone Dust for Cultivation of Grain.*

The exportation of bones from Germany to England, constitutes a singular epoch in the annals of commerce. Myriads of tons have been already exported without glutting the market, or causing a cessation of the demand. In the vicinity of the North Sea mills have been erected to pulverise them. This bone powder, or bone dust, was long ago exclusively applied to the purposes of hot houses by German horticulturalists; but the English, emboldened by their riches, have extended its use to general objects of agriculture, and fertilize, by these expensive means, their cold, humid, and poorest land; and have thus brought the uplands of Nottinghamshire, the western parts of Holderness, &c. into the highest state of cultivation, both in point of extent and intenseness of fertility. There is, consequently, a proverb, "that one ton of German bone dust saves the importation of ten tons of German corn." As Malta formerly covered her naked rocks with foreign soil, so does England now fertilize her clay and sandy heaths with German bones. Near the sea coast even the church yards are robbed of their venerable relics, which is only ironically excused by rendering the German bone trade popular. An agriculturalist, being rendered attentive by this vast exportation, instituted privately some comparative experiments, the results of which prove that bone dust acts in the cultivation of grain, as compared to the best stable manure—1. In respect to the quality of corn as seven to five. 2. In respect to quantity as five to four. 3. In respect to durability of the energy of soils as three to two. It produces several collateral advantages—1. It destroys weeds. 2. It diminishes the necessity of suffering the land to lay fallow. 3. This concentrated manure, or substitute for manure, is more easy of conveyance, less laborious to spread, and can with facility be applied to the steepest vineyards or other inaccessible lands either in mountainous countries or in wet meadow land. 4. It renders agriculture practicable without cattle breeding, grazing, &c. [*Rep. Pat. Inv.*

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### ¶ *Analysis of Maillechort.*

An alloy which resembles, pretty well, silver and polished platina, has been manufactured for some years at Paris; it evidently resembles the German silver, now extensively employed in England. M. Dumas, (Jour. de Pharm. Feb. 1832,) gives the annexed analysis, which will show that it differs not very materially from that of the German silver, given some time since in the Mechanics' Magazine.

| *Maillechort.* | | *German Silver.* | |
|---|---|---|---|
| Copper, | 66. | Copper, | 53.9 |
| Zinc, | 13.6 | Zinc, | 29.13 |
| Nickel, | 19.3 | Nickel, | 17.48 |
| Iron and sulphuret of arsenic | trace | | |
| Loss, | 1.1 | | 100.00 |
| | 100.0 | | |

Papers on *white Copper*, which is an alloy similar to the above, will be found in the Philosophical Magazine, vol. 63, p. 119, and vol. 64, p. 73. [*Philo. Mag. April*, 1832.

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## ¶*Expansion of Iron Pipes by Heat.*

From minutes of recent conversations at the Institution of Civil Engineers.

Instances of expansion in iron pipes of various lengths, caused by an elevation of temperature were adduced. A set of pipes at Manchester, two hundred yards long, was observed to expand to the extent of seven inches. A pipe of one hundred and eighty feet long expanded one inch and three quarters, from change of temperature.

[*Athenæum.*

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## *Meteorological Observations for July*, 1832.

| Days | Therm. Sun rise | Therm. 2 P.M. | Barometer. Sun rise. | Barometer. 2 P.M. | Dew point | Wind. Direction. | Wind. Force. | Water fallen in rain. Inches. | State of the weather, and Remarks. |
|---|---|---|---|---|---|---|---|---|---|
| ☽ | | | | | | | | | |
| 1 | 63° | 92° | Inches 30.10 | Inches. 30.05 | 62 | W. | Breeze. | | Light clouds. |
| 2 | 67 | 84 | 00 | 29.90 | 62 | SW. | do. | | Clear day. |
| 3 | 72 | 82 | 29.90 | 80 | 57 | NNW. | do. | | Light Clouds. |
| 4 | 70 | 90 | 85 | 90 | 55 | W. W. | do. | | Clear day. |
| 5 | 63 | 90 | 90 | 90 | 55 | SSW. | do. | | Clear day. |
| 6 | 72 | 90 | 90 | 90 | 57 | SSW. W. | do. | | Lightly cloudy—clear. |
| 7 | 70 | 92 | 80 | 80 | 61 | SSW. | do. | | Light cl'ds—Therm. at 12 |
| 8 | 70 | 94 | 80 | 80 | 73 | SSW. W. | do. | | [94 |
| 9 | 63 | 87 | 70 | 70 | 66 | E. S. | do. | | Cloudy—clear. |
| 10 | 64 | 77 | 65 | 65 | 56 | E. | Calm. | | Cloudy—rain. |
| 11 | 56 | 63 | 65 | 65 | 55 | W. E. | Breeze. | .07 | Cl'dy; fly'g cl'ds: thund. |
| 12 | 56 | 71 | 65 | 65 | 52 | W. N. | do. | | Showery: fly'g cl'ds: [sh w'r. |
| 13 | 58 | 73 | 65 | 65 | 52 | W. | do. | 1.00 | Clear—flying clouds. |
| 14 | 57 | 77 | 70 | 70 | 52 | W. | do. | | Clear—sh'w'r—high wind |
| 15 | 58 | 78 | 80 | 80 | 56 | W. | do. | | Light clouds. |
| 16 | 60 | 76 | 90 | 90 | 57 | W. | do. | | Clear day. [shower. |
| 17 | 63 | 83 | 94 | 90 | 57 | SSW. | do. | .03 | Clear; overcast; thunder |
| 18 | 64 | 83 | 30.00 | 90 | 65 | W. | do. | .01 | Clear; light clouds: rain. |
| 19 | 60 | 78 | 30.00 | 30.00 | 65 | W. | do. | | Cloudy—clear. [high. |
| 20 | 69 | 78 | 29.60 | 29.70 | 62 | W. | do. | .42 | Cloudy—clear : thund. sh'wr. wind |
| 21 | 69 | 82 | 60 | 60 | 64 | W. | do. | .04 | Clear day; sh'w'r, ev'n'g. |
| 22 | 62 | 82 | 70 | 70 | 56 | W. | do. | | Clear—flying clouds. |
| 23 | 59 | 84 | 70 | 70 | 54 | NNW. | do. | | Clear day. |
| 24 | 59 | 84 | 65 | 65 | 55 | W. | Calm. | | Clear—flying clouds. |
| 25 | 61 | 82 | 90 | 90 | 55 | W. | do. | | Cloudy—drizzle. |
| 26 | 72 | 78 | 71 | 71 | 51 | W. | Breeze. | .04 | Fly'g cl'ds. clear: lt. rain. |
| 27 | 70 | 76 | 70 | 70 | 53 | W. N. | do. | | Clear—flying clouds. |
| 28 | 62 | 78 | 65 | 65 | 51 | W. | do. | | Clear day. |
| 29 | 60 | 80 | 60 | 55 | 53 | W. | do. | | Clear—flying clouds. |
| 30 | 60 | 84 | 30 | 30 | 58 | W. | do. | | Lightly cl'dy; clear; rain |
| 31 | 65 | 84 | 90 | 90 | 65 | S. | do. | .40 | Cloudy—clear [in night. |
| Mean | 63.97 | 82.29 | 29.83 | 29.81 | 55.4 | WNW. | do. | 2.07 | Light clouds—cloudy. |

| | Thermometer. | Barometer. |
|---|---|---|
| Maximum height during the month, | 94. on 7th. | 30.10 on 1st. |
| Minimum do. | 56. on 11th & 12th. | 29.60 on 20th and 21st. |
| Mean do. | 73.13 | 29.82 |